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# POWER

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POWER GENERATION
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REFRIGERATION
PUMPS & COMPRESSORS
STEAM SERVICES
ELECTRICITY & ELEVATORS
INSTRUMENTS & CONTROL
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POWER MISCELLANY

## MARCH, 1937


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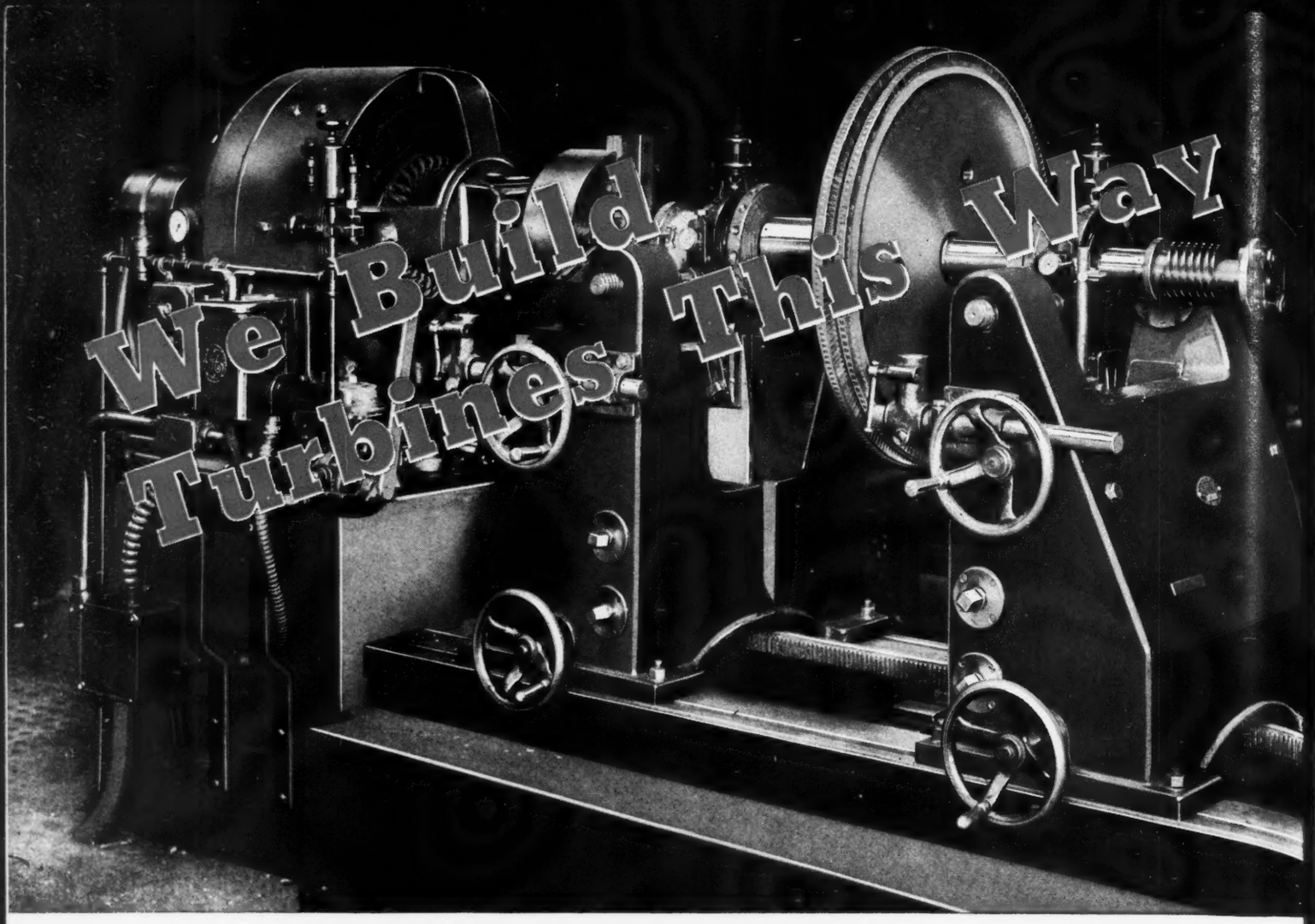


*A glimpse into the world's largest small-turbine workshop*

# DYNAMIC BALANCE

YOU are visiting the world's largest small-turbine workshop—the small-turbine engineering and manufacturing departments of the General Electric Company. In these shops are performed the tests and multiple checks that guarantee G-E quality. Here you see G-E performance in the making.

Many years ago General Electric turbine engineers pioneered in the study of turbine rotor vibration and its destructive effects. Today, as a result of that early work, this problem has been solved by improved rotor designs and by such tests as the one you see. This method, known as the Lawaczeck-Heyman system, makes it possible to measure and correct any tendency toward rotor vibration before the completed turbine is ever tested under steam.

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G E N E R A L

P O W E R

A McGRAW-HILL PUBLICATION—ESTABLISHED 1882—PHILIP W. SWAIN, EDITOR

# One-Hoss Shay

OLD DOCTOR HOLMES—Oliver Wendell—made poetry of a mechanical dream in his story of the "One-Hoss Shay." No one part was better than another. No durability was wasted. At the self-same second every part disintegrated and left the deacon sitting triumphantly on a pile of sawdust and carriage bolts. His theory was correct.

To date no one-hoss shays of this description have been built, but we have the practical equivalent in many power plants now operating. True, the elements are not of equal strength and natural life, but the effect is the same; the boiler lets go and, in no more time than it takes for a tangle of tubes and drums to fly up and fall down again, the whole plant is a steaming pile of brick, mortar and junk.

In the normal run, boilers grow old gracefully and are retired in ample time, like saddle horses. Yet some, mistreated too long, choose another exit. Their finish is a blaze of destruction—complete recompense for a life of abuse.

This sort of thing isn't supposed to happen so often in these modern times, when science has learned to control all sorts of fearful forces, but it does more frequently than some of us like to think. Right now is a time of particular peril, as has been demonstrated in recent months.

The average age of all boilers, considered as a group, is probably at least five years more than it was in 1929, because few have been installed or removed since then. And if we measure age not by years, but by actual deterioration, many have aged at least ten years since 1929. Boilers frequently or continuously cold are easy meat for external corrosion. All this potential misery breaks into the open as business starts booming again and the cripples are forced to do a man's work.

One of the most disastrous of recent explosions reveals a prime danger spot in many other plants—blind mud-drum heads in bent-tube boilers set in battery. The shell end at the head had wasted by external corrosion to $\frac{3}{16}$-in. thickness and the rivet heads were three quarters gone.

Our urgent suggestion to readers who value their lives and property is to take no chances. Invite the most thorough inspection by the most experienced and conscientious experts. Spare no expense to uncover the hidden danger spots, particularly blind heads. Don't be deceived by what appears to be a full rivet head but is really what's left of a head marooned on a hump on tissue-thin plate. Remember that badly corroded heads may simulate the original smooth contour. If there's any doubt, have plates drilled to check safe thickness.

In its early days *Power* constantly stressed boiler safety and did its bit to encourage those developments in design, construction materials and operation which so enormously reduced the hazard through the era ending in 1929. But we have been set back years in this respect. Notes of warning must again be sounded until the hazard has been reduced to normal proportions.

With the retirement of older units that day will come, for the modern boiler—with all the benefits of modern metallurgy, improved codes and better shop practice—is far safer than its grandfather was on his first birthday. And with today's scientific operation it will have a far easier life.

# Improved Heat Balance, Cleaner Air, Cut Brewing Costs

**Centrifugal compressor with liquid-ammonia circulating system, 350-kw. turbo-generator and 12 air-conditioning units installed at the 3,300-bbl. Narragansett Brewery, Providence, R. I.**

SINCE the repeal of Prohibition, the Narragansett Brewing Co. has been called upon to supply a steadily increasing volume of ale and beer, finally requiring the addition of brewing equipment that brought capacity up to a maximum of 3,300 bbl. a day. At the same time it was decided to air-condition fermenting rooms, stock cellars and yeast-storage room. This, together with the increased brew, required additions to refrigerating and power facilities. Changes made in the power plant are of unusual interest because of the great improvement in heat balance and the new refrigerating methods.

Before the changes, d.c. was generated by three engines supplied with steam at 100 lb. pressure. A.C. was purchased. Two vertical 2-cyl. ammonia compressors of 250- and 175-ton capacity, driven by horizontal Corliss engines, and three vertical condensers, supplied refrigeration capacity. All engines operated against a back pressure of 3 to 5 lb., but because exhaust was contaminated with oil it was not used in the brewery, so was largely wasted.

Fig. 1—From left to right, Cecil I. Elliott, Carrier Corp.; Otto S. Myer, plant engineer; Walter Jones and A. A. Berestneff, Carrier Corp.; Otto Henn, brew master

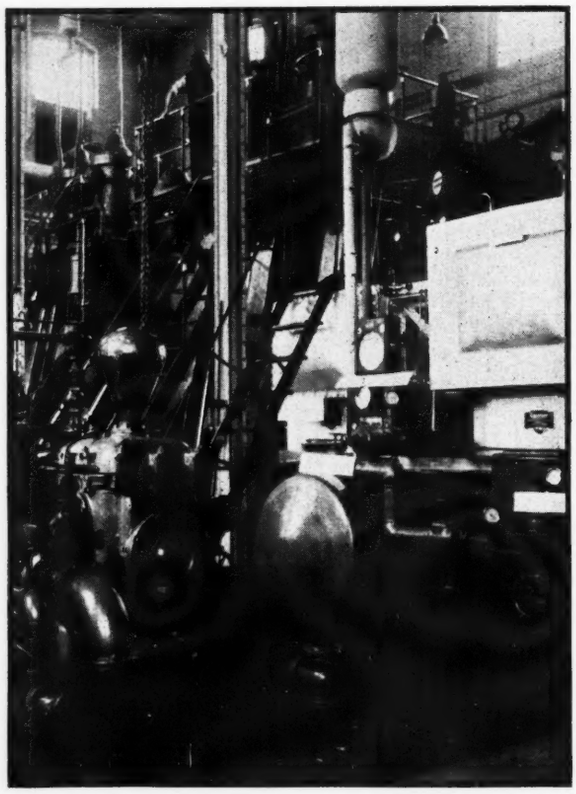


Fig. 2—Old vertical compressors of 1896 and 1904 at left, new unit at right

Ammonia evaporators in fermenting rooms and cellars were of a direct-expansion coil type and beer and wort coolers of the double-pipe type. Liquid ammonia was circulated to all of the various evaporators, which were provided with hand expansion valves.

It was necessary that the new refrigerating equipment be capable of operating with the old equipment and also desirable to make exhaust steam available for brewery process. This led to installation of a 200-ton Carrier centrifugal refrigerating unit driven by a Terry turbine at 4,200 to 4,800 r.p.m. The centrifugal 3-stage compressor employs monofluorotrichloromethane as refrigerant. With this refrigerant, condensation is at a slight vacuum and evaporation at +5 deg. F. is at 24-in. vacuum. Thus the entire compressor system is under vacuum. At maximum load, the compressor handles 6,000 c.f.m., or 30 c.f.m. per ton of refrigeration.

Liquid refrigerant is first discharged through a trap to an economizer, where the pressure is reduced and the flash vapor admitted to the second stage of the compressor. A liquid pump then distributes the

cold refrigerant over the tubes of a 6-pass surface evaporator and cooler. Ammonia vapor returning from the brewery passes through the tubes of this evaporator-cooler, and is there condensed at low pressure.

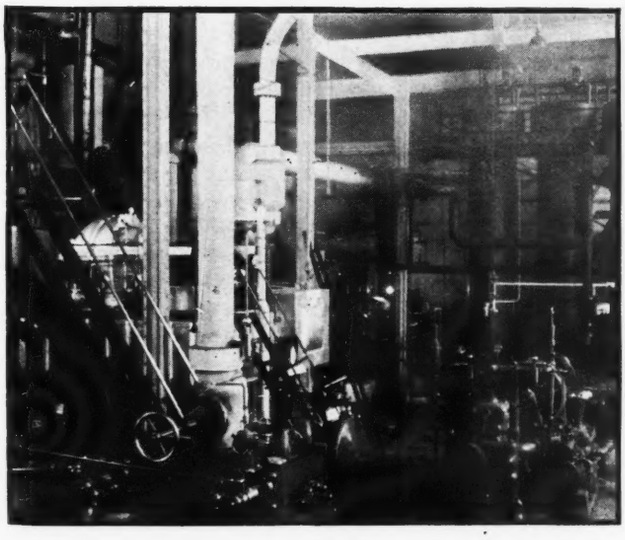
Liquid ammonia collects in a low-pressure receiver on the engine-room floor between the condenser and cooler of the centrifugal unit. A motored reciprocating pump in a pit below the receiver pumps liquid from the low-pressure receiver into the high-pressure ammonia liquid lines of the old system. The liquid ammonia pump has very little static head on its suction, hence receives ammonia practically at its boiling point. For this reason, an over-capacity pump (about 30-g.p.m.) was installed and a bypass with a spring-loaded relief valve provided through which excess liquid is returned to the receiver.

When only the centrifugal unit is operating, liquid ammonia delivered to the brewery evaporators is close to the evaporation temperature, hence little flash vapor is produced during expansion. This increases the capacity of the evaporators. When, however, the old compressors operate, the mixture of liquid from the old and new systems would be at considerably higher temperature, and readjustment of all the expansion valves would be necessary. To avoid this, liquid from the old system is expanded to suction pressure in an accumulator from which the cooled low-pressure liquid overflows to the low-pressure receiver. Here it mixes with liquid from the new unit, which is at practically the same temperature.

All ammonia gas from the brewery passes to this accumulator before entering either the suction of the old compressors or the liquefier of the new unit. The accumulator provides a means for separating slugs of ammonia liquid and oil that may be returned from the brewery. Oil falls to the bottom of the accumulator, from which it may be drained off. A considerable quantity of oil has been removed from the system through this drain.

To purge air from the ammonia liquefier, a $\frac{1}{2}$-ton compressor is connected to the last pass of the condenser and the top of the low-pressure receiver. Air and vapor removed by the compressor is discharged to the high-pressure receivers, where the air is removed by the purge equipment of the old system.

Fig. 3—Vertical condenser for old ammonia system at right



As may be seen from Figs. 2 and 3, the centrifugal compressor and turbine drive are mounted on top of the condenser and evaporator. Turbine speed is governed through an oil relay by a thermostat placed in the ammonia. Thus, as load increases, turbine speed is increased and pressure in the ammonia return line is kept constant.

Exhaust from the compressor turbine normally supplies part of the brewery demand for process steam. But when the demand for process steam is light, this exhaust, at 20-lb. pressure, is delivered to the low-pressure cylinder of a new mixed-pressure bleeder-condensing Terry turbine of 350 kw. capacity. The turbine is also supplied with 100-lb. steam from the boilers and operates at 4,500 r.p.m., driving through a reducing gear a Crocker Wheeler, 312-kva., a.c. generator and a 100-kw. d.c. generator and exciter. When the demand for process steam is high, steam is bled from the turbine to the process-steam header. At other times, the demand for steam is greater than can be supplied by both turbines, so live steam is taken through a reducing valve. At maximum load, the compressor turbine will deliver about 12,000 lb. per hr. to process and the turbo-generator 10,000 lb.

The new turbines are designed so they can be changed for 250-lb. pressure, as it is expected that in the near future new higher-pressure boilers will be added.

Water for condensing the monofluorotrichloromethane is supplied by wells at a constant temperature of 54 deg. F. After passing through the refrigerant condenser, it is used in the Foster Wheeler surface condenser on the turbo-generator, and its temperature raised to 110 to 145 deg. It then goes to a hot-water storage tank and is used in the brewery. Thus, not only is heat in the steam conserved for brewery use but also all heat removed by the refrigerating system. A thermostatically controlled valve in the water line to the turbo-generator condenser controls the flow of water through the

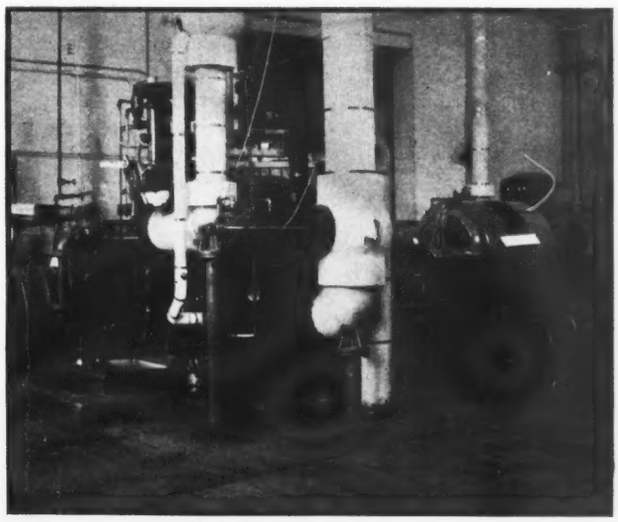


Fig. 4—New mixed-pressure bleeder condensing turbine makes a flexible unit for heat balance

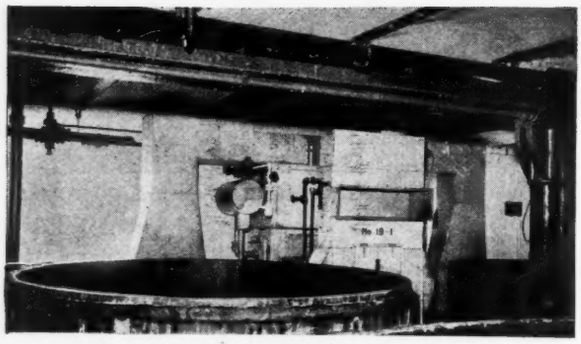


Fig. 5—Combination fresh-air, cooling and conditioning unit that holds ale-fermenting room at 54 deg. F. and 80% relative humidity

condenser to maintain a constant 25-in. vacuum. The temperature-sensitive element of the control is in the steam space of the condenser.

Five fermenting cellars, two stock cellars and the yeast storage room are air-conditioned by 12 Carrier unit conditioners. Units conditioning the stock cellars and yeast-storage room are of the brine-spray type with automatic control of temperature and humidity by interlocking hygrostat and thermostat in each cellar or room. Conditioners in the fermenting rooms are arranged so that conditioned air is supplied at floor level to avoid danger of air circulation carrying foreign bacteria into the fermenting beer. The other units are top discharge.

In some of the units flow of liquid ammonia is controlled by automatic thermal expansion valves; in others the coils are flooded and float valves and backpressure valves control the refrigerant.

To permit humidity control and take care of conditions when outside temperature is less than the desired indoor temperature, unit heaters are provided with the conditioners.

Air conditioning has eliminated sweating on the walls of the fermenting rooms and stock cellars, and permitted closer control of temperature conditions.

# Draft for Oil-Burning

*By James O. G. Gibbons*

*Consulting Engineer*

A FRIEND of mine, contemplating oil firing for his boilers, brought me an estimate of the stack draft he would require. It was considerably low, a not uncommon failing. This is what I told him:

While it is true that some burners—for instance, those atomizing with steam—can be operated with less draft than you will need for coal, some mechanical-pressure types entail so much loss at the air registers that unless you have a very high stack, high ratings are impossible without forced draft.

I can show you that the theoretical amount of air required per B.t.u. released is practically independent of the fuel. At 70 deg. F., the cu. ft. of air required to burn any fuel is almost exactly 1% of the B.t.u. value of the fuel, which works out by weight at 7.50 lb. of air per 10,000 B.t.u. On this basis, 14,000-B.t.u. coal will require 10.50 lb. of air per lb. of coal for perfect combustion and 18,000-B.t.u. oil will require 13.50 lb. of air per lb. of oil. Then, if we assume 20% excess air for oil and 40% for coal, and ignore the small difference in weight between the fuels, we find that for a given B.t.u. release the ratio of fuel-gas weight is 120 to 140, or less than 12% difference.

Usually, increased efficiency of fuel oil over hand-fired coal is about 65 to 75%, and may be even more, which means that less flue gas is handled by a stack. But you will undoubtedly want to take advantage of the possibility of operating your boiler at higher ratings with oil, in which case the actual amount of flue gas will be greater. And the difference between oil and stoker-fired coal is not very pronounced, either in efficiency or steaming capacity, although higher ratings can sometimes be obtained with oil. So, actual saving in the amount of flue gas is probably due to the smaller amount of excess air required, which should not exceed 12 to 15%.

Other things being equal, draft depends on stack height, and effective draft at the base will depend almost entirely upon the amount of gas handled. But, as I have tried to indicate, unless present and future operating conditions are known, it is rather unwise to assume that draft will be less with oil than with stoker-fired coal.

Draft loss in the furnace itself must be considered. Offhand, resistance appears to be less with oil, as the fuel bed is eliminated, but you can not assume that resistance of air openings is negligible. Indeed, it may be very high with register-type openings and air velocity much greater than you might expect. The entire mass of air must be brought up from zero to maximum velocity, which means that draft must create velocity head as well as overcome frictional resistance. For this reason, shape and size of air inlets should be considered carefully.

Engineers have found that substituting a steam-atomizing burner for a mechanical burner with the same air-intake register requires less chimney draft, a natural result of the strong injector effect of the steam jet. Another practice is "back-shooting" a steam-atomizing burner, that is installing it at the rear of furnace in which case steam-jet action may be quite different.

Finally, I suggest that you refer to manufacturers' data on resistance of their air-intake registers under different conditions. However, with steam-atomizing burners, the question of proper design of air-intake ducts is generally left up to the judgment of the furnace designer. In this case, keep velocities as low as possible, and if there is any question about stack adequacy, do not forget that if air is brought any distance under the furnace floor, its temperature and volume may be greatly increased.

# No Soot; No Suit

*By Anthony A. Fette*

*Chief Engineer,*
*Cincinnati General Hospital*

**As Cincinnati grew, the City Smoke Department got more and more complaints. It couldn't be smoke—that had been checked. Finally, the hospital turned out to be the culprit—every time soot was blown, it went out of the stack and settled on the country 'round. Here's Mr. Fette's economical solution**

CINCINNATI General Hospital has the highest chimney in southwestern Ohio, 250 ft. high with 8-ft. top and 12-ft. bottom inside diameters. It was built 25 yrs. ago when the plant was put in—for natural-draft furnaces of greater capacity than now will ever be needed. In 1925, two Murphy V-type furnaces were fitted with underfeed stokers to replace dutch ovens, and in 1928, the remaining three furnaces were equipped with underfeed stokers and accompanying fan blowers to provide air pressure through stoker tuyeres. This made unnecessary the high stack draft of 1.25 to 1.50 in. of water, but no change was made in the chimney or uptake.

Complaints about "smoke" to the City Smoke Department became more insistent as the neighborhood became more thickly populated. But it couldn't be smoke—there were no smoke ordinance violations. Finally, the Department realized that soot from the Hospital chimney was causing the trouble. So I designed and specified fly-ash and cinder traps for the chimney breeching. Bids were called for by the City Purchasing Department, but the single bid received was much too high for the Hospital's operating budget, and the purchase was dropped. I then decided on a home-made water-spray ring, placed in the chimney above the breeching entrance and constructed by the Hospital maintenance crew.

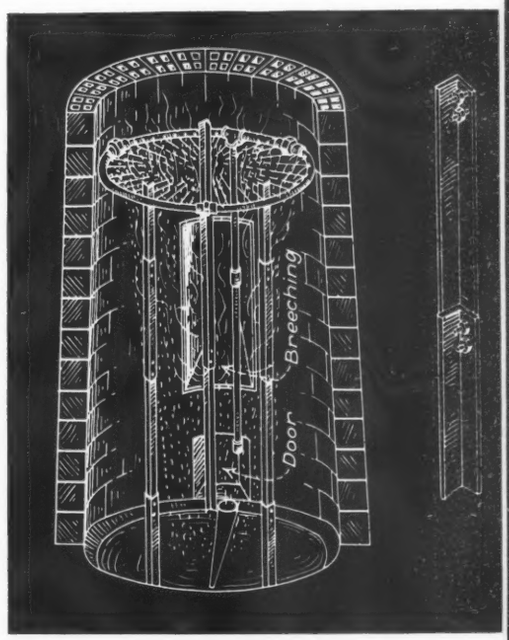
We bent three lengths of ¾-in. brass pipe into a circle around the 12-ft. flywheel of a power-plant engine, then drilled 3/64-in. holes, 1 in. apart, slightly below center on the inside of the ring so that spray would be downward. We threaded the ends and connected them by brass unions.

Total cross-sectional area of perforations was computed, and we found that a 1½-in. pipe was necessary to furnish sufficient pressure to give spray all around the ring. A 1½-in. brass tee with bushings was put on one of the joints, to be connected to a brass pipe running through the door at the chimney bottom.

The ring was erected temporarily in the boiler room about 6 ft. in the air and tests showed that water spray from all perforations met in the center near the floor. It was dismantled, and pieces were passed through the chimney door. At this point, however, we ran into our greatest erection difficulties. Breeching-entrance bottom is only 4 ft above the chimney floor, and eddying flue-gas currents made it impossible to work in the chimney. Gas masks were tried unsuccessfully; then, we placed several electric fans on the chimney floor, tied cloths over workers' noses and mouths, and were able to proceed with erection.

After the ring was reassembled, it was raised 4 ft. and attached with U-bolts to stanchion posts of 1½-in. angle iron, equally spaced around ring circumference. Then the ring was raised another 4 ft., another section added to each stanchion, a section of 1½-in. brass pipe screwed into the supply tee, the raising process continued, and another length of supply pipe added.

I thought at first that hot flue gas would evaporate the spray, but instead, over a foot of water collected on the chimney floor. This was eliminated by drying the chimney bottom and pouring a concave concrete floor sloping into the center to a trough which drained out through the door. As the chimney base is about 6 ft. above the boiler-roof floor, a sump drain could be installed in front of the door and a 3-in. drain pipe cemented under the floor through the wall to carry off excess water and soot. Water flowing from this drain is boiling hot.




**A soot eliminator of ¾-in. brass pipe. Water sprays wash the soot down to the base sump**

Operating details are simple. Zeolite-softened water is used to prevent scaling of pipes and perforations. A large rectangular tank under the open end of the drain pipe allows most of the soot to settle out, and after water has run off, soot is shoveled into a wheelbarrow and taken out to the ash pile.

The plant fireman turns on the water spray just before he turns on steam in the five soot-blower elements of our water tube boilers. Drain water at first flows clear, then gradually turns black and continues black until soot-blowing is finished. This is done three times per 24 hr. of boiler operation.

The spray ring has been in operation about 2 yr., and in that time no complaints have been received about soot deposits. The chimney emits practically no solids, especially when soot is being blown from the boilers

# Coal Selection for the Industrial Plant

*By T. A. Marsh*

*Iron Fireman Mfg. Co.*

MUCH industrial coal is improperly selected. The cause is lack of proper information on the part of the purchaser and frequently on the part of the vendor.

The first step in selecting a coal is to tabulate all coals available to that market, with notes regarding important characteristics, delivered cost per ton and delivered cost per million B.t.u.

Few buyers know their entire market and its possibilities. Some vendors do not. Some do not present the entire market analysis, which should be considered in regard to the following items; ability to generate sufficient steam fast enough to satisfy load demand, and continuity of steam supply.

Involved in this are factors that affect primary operation, which include burning characteristics of the coal, its suitability to the grates or stoking equipment, ash fusion temperature, heating value and commercial size. Economy of any fuel is determined by the cost of coal, labor, ash disposal, maintenance and capital charges (if changes are required) per 1,000 lb. of steam produced.

It is well to also consider such supplementary information as storage properties, tendency to cause fly ash, reliability of the company, reliability of supply, mine preparation and size.

Only those coals can be considered that will meet the first specifications of primary operation. This is the first limitation to the list of available coals. The list should be so marked, indicating the coals that can and can not be used.

After the list has been limited to those coals that will carry the plant load, selection of the most economical coal is the next step. This analysis should be made on a unit cost basis just as other manufacturing costs are determined.

Steam is a simple product to measure. It can be measured by flow-meters as produced or as water entering the boilers. The cost of the instruments to measure steam output is reasonable and there is less reason for not knowing the cost of steam than costs of any other shop department.

Capital charges of interest and depreciation may be neglected when coal is selected for an existing plant until such time as changes in equipment are contemplated to make usable coals of poorer quality.

Neglecting capital charges for the moment, the list of coals is narrowed a second time to the usable coal that offers lowest cost potentialities. A good indicator is the delivered cost per million B.t.u. This, however, is not conclusive, as the final answer is *performance*.

Performance does not refer to short tests. A 30- or, preferably, a 60-day run should be made on a given coal so that definite costs of fuel, labor and maintenance under operating conditions can be determined. Each qualifying coal should be tested.

When testing is complete, a report should be made to the purchasing department, indicating what relative price may be paid for each qualifying fuel.

### Supplementary Performance

A low-cost coal would be unsuitable if storage is involved and the stored coal deteriorates so as to unduly increase costs, or is prohibitive, if such stored coal jeopardizes ability to make enough steam.

Flashy coals and some sizes in certain coals are difficult to burn smokelessly. This becomes an objec-

tion in many instances. Frequently changes in operation and minor physical changes may make such coals suitable.

Fly ash is not usually thought of as a coal characteristic. However, some coals cause more fly ash than others. This is often objectionable.

When the three major considerations have been met, the coals are known that will carry the load, make low-cost steam and be satisfactory from supplementary standpoints. Individual selection of the coal and the company is then a matter pertaining to reliability of the company and of supply, uniform quality, mine preparation, transportation, and engineering service. When large tonnages are involved, it is evident that trips to, and surveys of, mines and equipment are warranted.

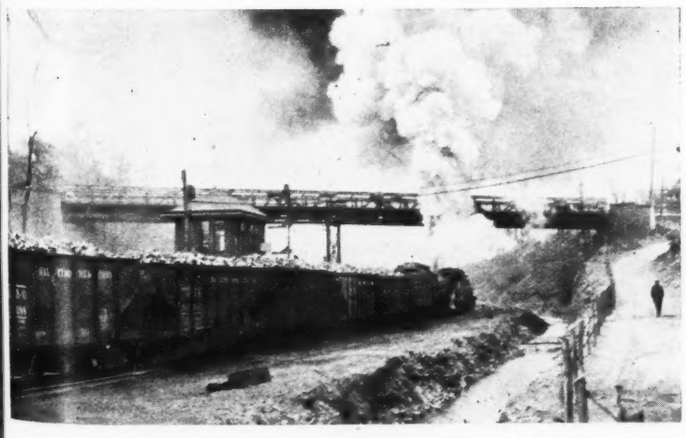
Engineering service is often of real value, as fuel engineers are frequently able to suggest changes in operation or slight physical changes in equipment that will make fuel more adaptable and of lower ultimate consumer cost than would be the case without such engineering advice.

Up to this point, coal selection has been based on making no changes to plant equipment. The problem does not end here. There should be further thought given to the fuel satisfaction that might be obtained if changes were made to broaden the range of usable fuels. Changes have to do with cost of steam and may be analyzed on this one item.

Usually there are several possible lines of procedure. In each case, one procedure only is economically correct, the others, while perhaps quite beneficial, fall short. In determining the economy of equipment changes, figure the investment charges. Accountants use varying figures between 13 and 15% for the sum of the interest and depreciation. Maintenance must be included, and also operating charges, such as power. Many large industrials will make improvements if self-liquidating in 3 yr. Savings, in any event, must carry the capital charges.

The labor item is often changed with plant changes. In large plants it is decreased, in small plants it is usually unchanged. There have been cases of improper engineering where it has been increased. Finally, the contemplated changes must bear the scrutiny and cold financial analysis of the effect on steam costs, considering the entire list of coals available.

With the procedure thus outlined, let us consider a specific problem and make a rational fuel selection.



The plant contains two 1,500-sq.ft. hand-fired h.r.t. boilers. Peak load is 8,500 lb. per hr. per boiler and annual output is 40,000,000 lb. of steam. Draft is fair, furnace volume limited and smoke bad. Two firemen are required, 1 man per shift at \$900 per year = \$1,800.

The table shows fuels available to this plant. Due to load conditions, draft and furnaces, coals *A, B, C, E, G, H* and *I* were usable, while coals *D, F, J, K, L, M, N, O, P, Q* and *S* did not comply with the primary operation factor—ability to make enough steam. Thus the low-cost fuels were not usable. After actual trial, Coal *I* was selected, having 12,000 B.t.u. per lb. delivered at 14.79 c. per million B.t.u. The plant operated on this most suitable coal for its existing condition with a cost per 1,000 lb. of steam as follows:

| | CENTS |
|---|---|
| Coal | 28.67 |
| Labor | 4.5 |
| Maintenance | 0.1 |
| Ash removal included in labor | ..... |
| Total | 33.27 |

The coal used per year was 3,230 tons delivered price was \$3.55, making the annual fuel bill ..... \$11,468.00

| Coal | Characteristics | B.t.u. as delivered | Delivered cost per million B.t.u., cents | Coal cost in cents per 1,000 lbs. of steam based on efficiency of 70% | 50% |
|---|---|---|---|---|---|
| A | Fast strong coal | 13,800 | 18.98 | 26.31 | 37.39 |
| B | " " " | 13,500 | 18.49 | 25.63 | 35.88 |
| C | " " " | 14,000 | 18.17 | 25.18 | 35.25 |
| D | ..... | 10,500 | 17.85 | 24.54 | 34.35 |
| E | Fast strong coal | 13,200 | 17.76 | 24.40 | 34.16 |
| F | Quality not dependable. | 11,200 | 17.41 | 23.93 | 33.50 |
| G | Fast strong coal | 13,100 | 17.13 | 23.54 | 32.95 |
| H | Low ash — flashy | 13.500 | 17.60 | 23.01 | 32.21 |
| I | Flashy fast coal | 12,000 | 14.79 | 20.48 | 28.67 |
| J | Slow — inert | 11,000 | 14.31 | 19.83 | 27.76 |
| K | Quality not regular | 11,000 | 14.07 | 19.50 | 27.30 |
| L | High sulphur | 10,500 | 14.04 | 19.46 | 27.24 |
| M | Difficult to store well | 11,500 | 13.69 | 18.97 | 26.55 |
| N | " " " " | 11,500 | 13.69 | 18.97 | 26.55 |
| O | ..... | 10,000 | 13.65 | 18.86 | 26.40 |
| P | ..... | 11,500 | 13.47 | 18.67 | 26.13 |
| Q | ..... | 10,800 | 13.19 | 18.22 | 25.39 |
| R | ..... | 10,800 | 13.05 | 18.09 | 25.32 |
| S | ..... | 11,200 | 12.95 | 17.98 | 25.20 |

It will be noted in the table that the cost per million B.t.u. for Coal *A* is 47% higher than for Coal *S*. Hand-firing Coal *S* would not show to such advantage over Coal *A*. With stoker firing, the relationship in the table is approximated. Note also that steam costs are 40% higher with any given coal for 50% efficiency (hand-fired) than with 70% efficiency (stoker-fired). In practice, the margin increases in favor of stoker firing as the quality of the coal decreases.

### Plant Improvement

Attention was then centered on those coals offering a lower cost per million B.t.u. that would be

made usable by plant changes. Various plans were considered, some elaborate and some rather simple. Selection was made for a change to stokers, as this opened a list of low-cost coals with minimum investment. Analysis indicated that this change would make the lowest steam cost—coal, labor, maintenance, operating and financial charges included. Financing was obtainable through the stoker company, thus removing this barrier.

Steam-cost estimates were based on Coal *Q*, having 10,800 B.t.u. per lb. as delivered, costing 13.19 cents per million B.t.u. This gave some latitude on still lower-priced coals. The estimated cost per 1,000 lb. was:

| | CENTS |
|---|---|
| Coal | 18.22 |
| Labor, unchanged | 4.50 |
| Maintenance | 0.30 |
| Power | 0.90 |
| Capital charges at 15% on $5,000 | 1.87 |
| Total | 25.79 |

Annual fuel consumption was figured at 2,566 tons at a delivered price of $2.85, making the annual fuel bill $7,313. Actual plant operating costs were within the estimates, and a summary of the results obtained is:

| | BEFORE | AFTER |
|---|---|---|
| 1 — Tons of coal annually | 3,230 | 2,568 |
| 2 — Annual fuel bill | $11,468.00 | $7,313.00 |
| 3 — Cost per 1,000 lb. of steam | 0.3327 | 0.2579 |
| 4 — Pounds of steam per year | 40,000 | 40,000 |
| 5 — Total annual gross steam cost | $13,308.00 | $10,316.00 |
| 6 — Investment required | ..... | 5,000.00 |
| 7 — Annual saving after all charges | ..... | 2,892.00 |
| 8 — Period required to pay for changes from savings | ..... | 21 months |

In the case presented, more information was available than is the usual case. In most instances, the only information is the present fuel bill. The usual procedure then is:

1. Make a boiler test to determine the fuel cost per 1,000 lb. of water evaporated.
2. Calculate the cost per 1,000 lb. of water evaporated based on the proposed coal and changes.
3. Figure the per cent saving and calculate this per cent on the past fuel bills.

(Allowances must be made for increases or decreases in fuel bills due to business conditions or other factors.)

It is interesting to note as a side light that with increased efficiency of stoker firing the owner could have paid $4.97 per ton for the original coal instead of the market price of $3.55 and still have been even with his old costs. This emphasizes the thought that stokers enhance fuel values.

# A Return Line Corrodes

*By H. A. Ward*
*Dept. of Buildings & Grounds, Cornell University*

CORNELL UNIVERSITY'S heating plant, besides furnishing steam to the campus, also supplies a laundry about 600 ft. away. Condensate return from the laundry is pumped through a 2-in. extra-heavy pipeline that runs up grade to a point near the heating plant, then pitches sharply downward. Just inside the plant, discharge from high-pressure traps joins the return line.

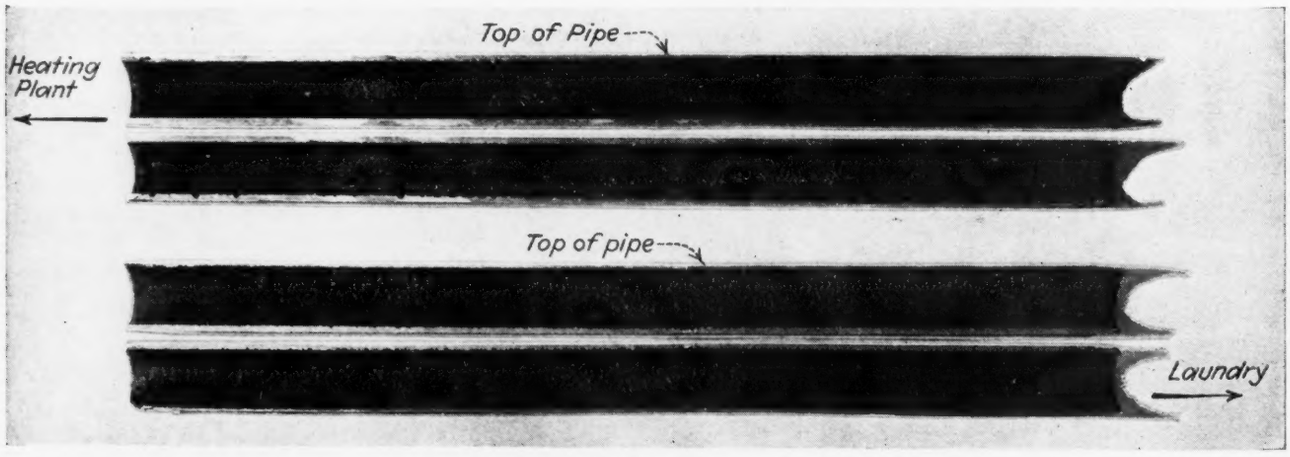
In January, 1930, the laundry was put in operation. Three years later, a puncture developed on the top surface of the return about 15 ft. from the plant, and by August, 1933, when piping was renewed, there were several plugged punctures. In August, 1936, a leak again developed a short distance from the plant.

Condition of the pipe at both sides of the leak is shown by the illustration. Note that at the heating-plant end, where the high-pressure trap discharge joins the return line, the pipe is in fairly good condition. Further along corrosion is more severe, both top and bottom. At the laundry end of the sample, corrosion of the bottom half fades out.

This is a good example of what may be expected when relatively cool returns containing air are mixed with hot high-pressure drips in a closed space. In this case, surge caused by the traps and pipe inclination mixed hot and cold water for almost 30 ft. up the return line. Cool water, as it was heated, released dissolved oxygen, which caused the corrosion shown at the top of the pipe.

From our experience, cool condensate returns and hot trap discharge can be mixed with small corrosive effect in an open feedwater heater or surge tanks because air released is carried out a vent.

**Sample of pipe taken from return line near heating plant. Puncture occurred at coupling between two samples. Original weight of top sample 14 lb., 12 oz.; present weight 11 lb., 12 oz. Original weight of lower sample 15 lb., 4 oz.; present weight 11 lb., 8 oz. In each case, both halves of the pipe are shown, with the tops (in the original position) outward.**



# Steam-Engine Control—I

*By F. J. Vonachen*
*Troy Engine and Machine Co.*

**This, the first of three articles, discusses the various types of control. The others will deal with the application of these controls to various engine-driven equipment**

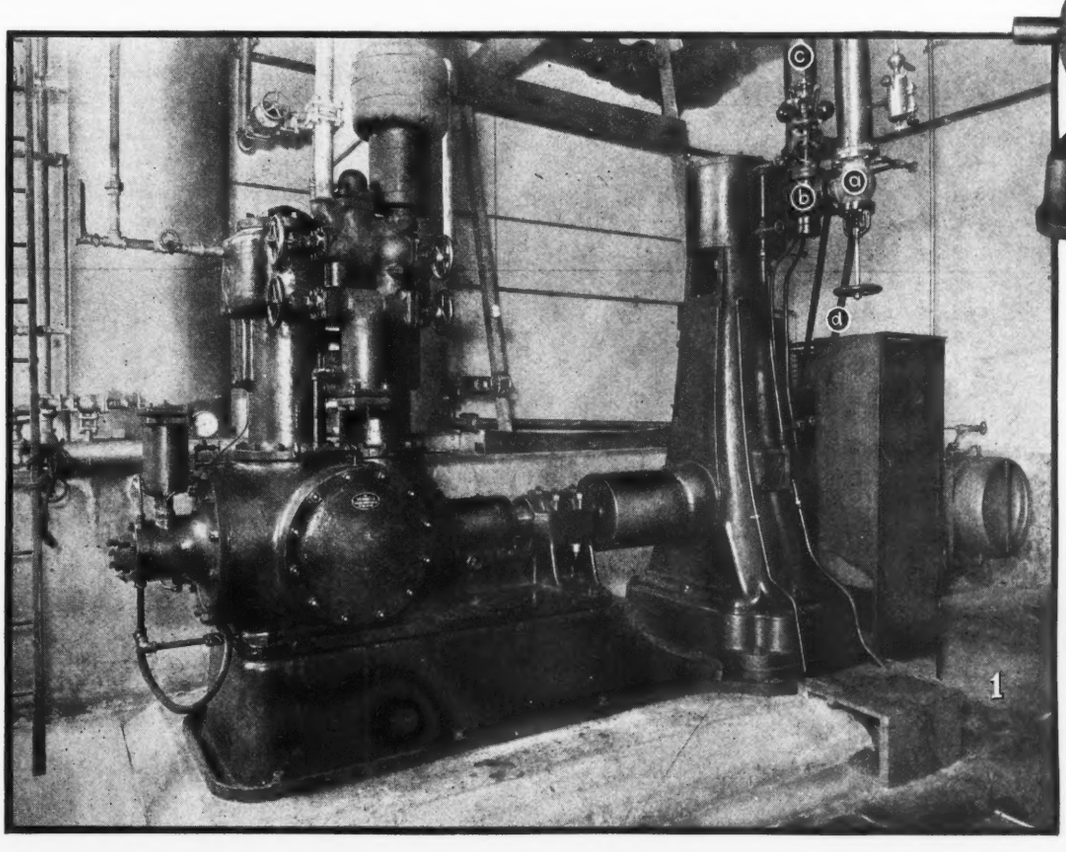
GREAT STRIDES have been made in the control of practically all equipment and processes. A small but important part of this vast subject is the control of steam-engine-driven equipment such as stokers, forced- and induced-draft ventilating fans, pumps, air and refrigeration compressors, cookers, driers, blowers, exhausters, presses, generators, etc. This is of interest primarily to mechanical engineers engaged in power-plant work and offers management an excellent method to improve operations, perfect products and reduce both operating costs and maintenance.

The modern steam engine lends itself to control due to its wide, smooth, flexible, easily adjusted speed range with infinitely small steps and the ease with which it can be connected to and operated by controls. Whether the control is manual or automatic, definite speed is maintained for each point of control. There is good regulation and, of prime importance, no hunting. Steam engine drive also has advantages in its production of low-cost "byproduct power" and in its low steam consumption.

### Engine Speed Control

Before taking up the application of control to particular types of driven machines and processes, it will be well to consider the control of the speed of steam engines in general. Four of the simplest controls are (1) hand-throttle valve, (2) throttling or flyball governor, (3) automatic or flywheel governor, and (4) engine regulator.

The hand-throttle valve, (*a*-Fig. 1) is well known and is used to hand-throttle steam to the engine in numerous installations because of its flexibility and simplicity. A throttling or automatic governor is usually used with it as a limiting speed control. A disadvantage of the hand throttle is the speed fluctuation resulting from change in load or steam pressure with a particular setting of the valve.



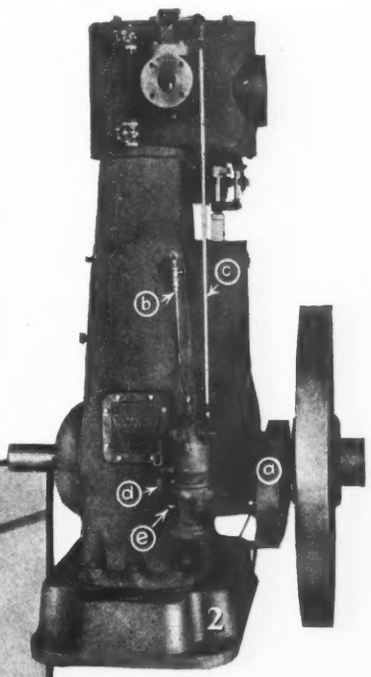




Fig. 1—Engine-driven refrigeration compressor, showing flyball governor and hand throttle. Fig. 2—Engine with variable-speed throttle governor

In the throttling or flyball governor (*b*-Fig. 1) a piston type of balanced valve is actuated by the centrifugal force of flyballs, which is balanced by spring tension. The flyballs are driven from the engine chankshaft. Speed variation is secured either by changing the length of the valve stem through an adjustment (*c*-Fig. 1) or by changing the spring tension (*d*-Fig. 2). The governor can be driven by flat belt (*d*-Fig. 1) in which case it is provided with an automatic stop that closes the valve if the belt breaks; or it can be driven by enclosed silent chain running in oil (*a*-Fig. 2). The governor can be oiled by the engine lubricating system (*b*-Fig. 2). Note the connection of the governor to the steam valve by a vertical rod (*c*-Fig. 2). With the throttling type of governor, the engine can be furnished with: (1) a fixed eccentric having a fixed point of cut-off, (2) a hand adjustable eccentric (Fig. 4) by which cut-off can be varied manually when the engine is not running, or (3) a variable eccentric (*a*-Fig. 3 and Fig. 5) by which cut-off can be varied manually while the engine is running by turning a hand wheel. This can also be arranged for remote or automatic control by the addition of a small electric motor to drive the handwheel. The last two devices, two and three, permit cut-off to be set at the most economical point, thus decreasing the steam consumption about 10% below that obtained with fixed eccentric. They also permit direction of rotation of the engine to be reversed.

Weighted arms attached to the engine eccentric mounted in and revolved by the flywheel are the main parts of the automatic or flywheel governor (*a*-Fig. 6). Centrifugal and inertia forces are balanced by spring tension. This type governs at constant speed by automatically adjusting the point of cut-off; has excellent speed regulation, within 2%; and is very simple. In case of spring breakage the arms fly out, close the steam valve and stop the engine.

Engine regulators (*a*-Fig. 8) can be any type of throttling or chronometer valve actuated directly or indirectly by flow, temperature or pressure of the substance to be controlled. It regulates steam supply to the engine and adjusts engine speed to maintain a predetermined value of the condition to be controlled. With it the throttling or automatic governor should be used as a speed-limiting control.

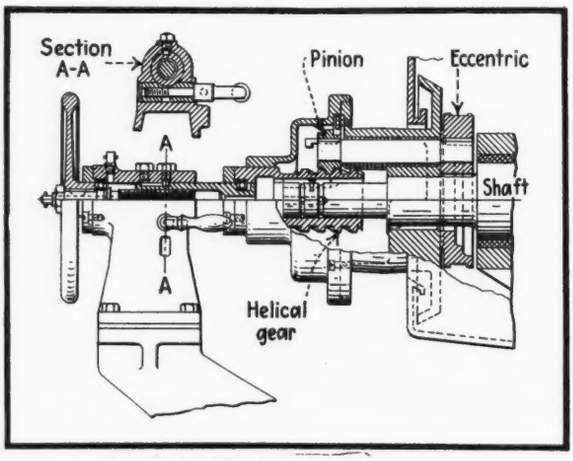



Fig. 5—Detail of arrangement for varying cut-off while engine is in operation

### Constant-Speed Control

For constant-speed service, such as driving a generator, the automatic governor is usually used because of its good speed regulation, economy, and simplicity. Because of its characteristics, it is better suited to the higher engine speeds and it is necessary to use the throttling type of governor for the lower constant engine speeds.

### Adjustable Speed—Manual Control

Adjustable speed can be obtained with manual or automatic control or a combination of the two. Manual control can be had:

1. By throttling the steam to the engine with a hand throttle valve (*a*-Fig. 1). Speed range is limited only by the speed range of the engine.
2. By manual adjustment of throttling governor through governor adjustments (*c*-Fig. 1 or *d*-Fig. 2). The maximum speed range with present governors

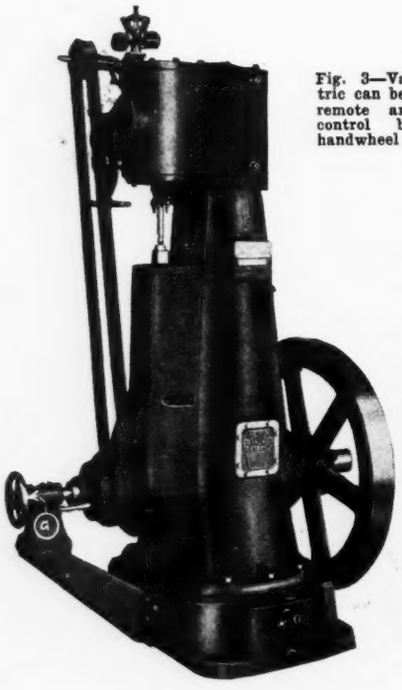
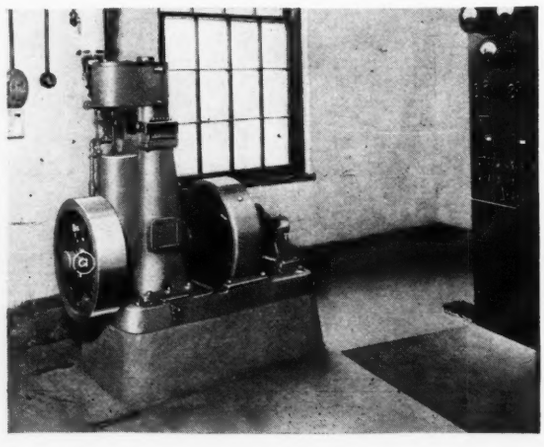


Fig. 3—Variable eccentric can be arranged for remote and automatic control by replacing handwheel with motor

Fig. 4—Hand adjustable eccentric

Fig. 6—Engine with flywheel governor



is 4 to 1, maximum to minimum, but experimental work has been done on throttling governors which have a 6 to 1 range. For wide speed range, this type of governor can be furnished with a V-port valve cage which makes the governor unusuallly stable at low engine speeds or light loads when the governor valve is just cracked. In this connection, it might be said that the duplex type of steam engine with the cranks at 90 deg. and no dead center is more suitable for wider speed range and lower speed than the single-cylinder engine.

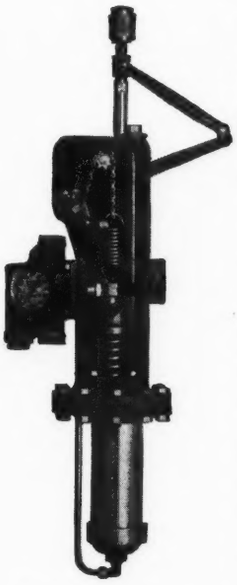


Fig. 7—An automatic controller for operating throttle valve or engine regulator

3. Through adjustment of a variable-speed transmission (*a*-Fig. 9). Here the variable-speed transmission is between engine crankshaft and throttling governor, the constant-speed shaft of the transmission being connected by flat leather belt to the governor, and the variable-speed shaft of the transmission being connected to the engine crankshaft by enclosed silent chain. Speed range of the variable-speed transmission, and consequently of the engine, for a particular setting of the throttling governor varies in different makes of transmission, but is usually about 5 to 1. If the setting of the throttling governor is varied, however, the speed range is limited only by the limits of the engine itself. This arrangement has an advantage for wide speed range over the use of the throttling governor alone if very close speed regulation is required. While regulation of the throttling governor is good throughout its speed range, there is one speed where it is best. It can be set at this point and the variation in speed secured by the variable-speed transmission. If necessary, the handwheel of the transmission can be connected for operation from a remote point.

4. By manual adjustment of a throttling governor as in (2) above except that the governor belt pulleys are cone pulleys to provide greater speed range than can be secured from 1-step governor pulleys.

5. By manual adjustment of a controller connected to an engine regulator, the controller indicating the value of the condition to be controlled and varying the engine regulator to suit.

Fig. 8—Engine regulator controls speed while governor acts as speed-limiting device

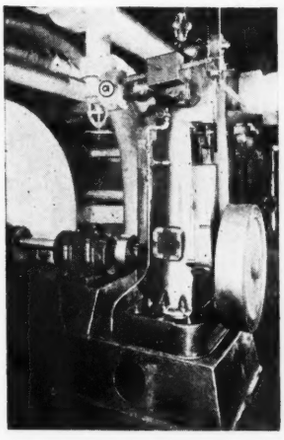
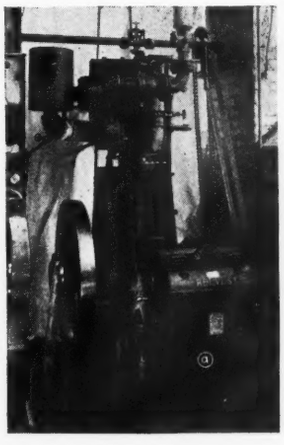


Fig. 9—Governor driven by variable-speed transmission



### Adjustable Speed—Automatic Control

With automatic control, the controlling factor which gives the "impulse" to the system is usually the flow, pressure, or temperature of the gas, liquid or material used in the process; or it may be the temperature of the space to be heated or cooled. In boiler-plant work, it may be the steam-pressure change as an indicator of the steam flow, or furnace draft as an indicator of gas flow.

These controlling factors actuate the automatic controller, one type of which is shown in Fig. 7, which transmits this impulse to the steam engine by means of a power element through a valve which throttles steam to the engine and consequently controls engine speed automatically. The throttling governor can be directly connected to the automatic-control power element, in which case the governor serves as the throttling valve, or the engine regulator or chronometer valve can be used, which requires throttling or automatic governor as a limiting-speed control for the engine. If the automatic governor is used, its speed should be about 50 r.p.m. above maximum speed to prevent pulsation of governor arms.

Any control system consists primarily of: (1) the *responsive element* which gives the "impulse" when the condition to be controlled varies from the predetermined value; (2) the *power element* which amplifies the "impulse" sufficiently to operate the regulating valve; (3) the *transmission element*—oil, water, air, steam pressure; electric current, or mechanical linkage—which transmits the amplified "impulse" to the regulating valve; and (4) the *regulating* valve.

Time lag between the "impulse" element and the machine operated can be secured by stabilizers, stabilized types of regulators, or compensators which prevent a complete stroke of the power element for small changes in the condition being controlled and make it possible to adjust the amount of movement of the power element for a particular change in the controlled condition. Controls are available which give a definite relation between the "impulse" and power element, also so that the rate of the impulse will be imparted as a similar rate to the power element.

Controls can be either the "on and off" type in which case the engine is operating at full speed or at idling speed; or they can be the "floating on the line" type, in which engine speed varies with load.

Next month a second article will discuss the application of these controls to specific engine drives.

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*FAILURE* to realize economies in pipe welding is a result of improper organization. A welding operator is a skilled mechanic, and should spend his time welding, not moving and lining up pipe. This may seem a very simple injunction, yet is the cause of many excessive welding costs—*From "Power Plant Piping," by W. A. Benoit, Asst. Engr., Anheuser-Busch, Inc., 37th Conv. Int. Acetylene Assn.*

# Carryover From Steam Boilers

*By H. M. Spring*

**Production of clean steam is a major plant-operating problem**

CLEAN STEAM plays an important part in economical power-plant operation. When it is contaminated with water, mineral solids or other impurities, numerous troubles develop and costs automatically increase. Foreign matter entrained in otherwise clean steam leaving a boiler drum is commonly termed carryover.

It can be eliminated or minimized by determining its cause and then applying the right correction.

The magnitude of the losses occasioned by carryover are not generally realized. Fuel consumption, equipment maintenance costs and plant safety are all affected. Here are some more common effects:

**Boilers—**

1. Deposits in piping of instruments, water columns and feedwater regulators affect safety and good operation.
2. Erosion or incrustation of non-return and stop valves, in some instances rendering them inoperative when needed in an emergency.
3. Danger of boiler destruction brought about by water-hammer shocks in the steam piping transmitted back to the steam nozzle.
4. Accumulations of solids ab ve the water line which may become dislodged and fall on high-temperature heat-transfer surfaces, causing the metal to become overheated.
5. False water level in gage glasses induced by surging or foam bubbles.

**Superheaters—**

1. Evaporation of moisture in entering steam reduces superheat and lowers over-all economy.
2. Solid deposits plug tubes, affect heat transfer and cause overheating of the metal.
3. Shocks from water hammer likely to damage the structure.

**Engines—**

1. Danger of wreckage if slugs of water enter the cylinders.
2. Washing effect of excess moisture on cylinder walls increases oil consumption.
3. Gritty particles cause wear of cylinder liners, pistons and valves.
4. Lowered factor of safety brought about by erosion or incrustation of stop, emergency and governing valves.
5. Increased steam rates due to reduced superheat or re-evaporation of moisture.

**Turbines—**

1. Erosion of valves and blading affects maintenance costs and steam consumption.
2. Excess moisture in steam increases leaving losses and aggravates corrosion.
3. Deposits in nozzles and blading interfere with steam distribution, causing higher steam rates and in some instances unbalance and vibration.
4. Damage to blading or wrecking of turbine by heavy slugs of water.
5. Incrustation of governing and emergency valves, causing erratic speed control, overspeeding and possible wreckage of the machine.

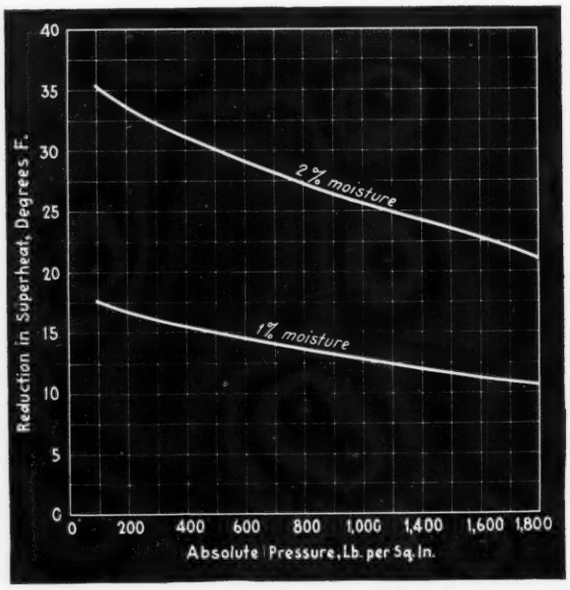



**Fig. 1—Loss of superheat with 1% and 2% moisture in the entering steam**

**Piping—**

1. Danger of wreckage by water hammer.
2. Erosion and incrustation of valves, inducing leakage or rendering them inoperative.
3. De-zincification of brass valves by the alkaline content of boiler concentrates in the steam.
4. Deterioration of asbestos in packing and gaskets caused by abrasion and chemical changes.
5. Trap troubles from deposits.
6. Heat-balance losses from excessive water in piping and traps blowing through.
7. Plugging or in some cases severe erosion of piping by the water and solids in the steam.

While some of these troubles are due to the entrainment of solid slugs of water, most of them come from the cumulative action of small quantities of carryover. As an illustration assume a 10,000-sq. ft. boiler operated at 400% rating and having

only 100 gr. per gal. of concentrated impurities in its water. It has been estimated that steam from such a boiler would carry with it in a month's time approximately 208,000 gal. of concentrated water containing 2975 lbs. of solid matter. 863 tons of water and roughly 1½ tons of abrasive solids can do a lot of damage.

What are the causes of dirt in steam? Carryover starts with the entrainment of droplets or slugs of water in the steam leaving the steam-disengaging surfaces of the boiler. This entrainment may be caused by violent boiling or may come from bubbles or foam partly filling or filling the steam space of the drum. These disturbances at the water surface are commonly referred to as priming and foaming.

There are many reasons for violent boiling. High evaporation rates, limited area of steam-disengaging surfaces, circulation characteristics of the boiler, and flashing of the water brought about by sudden pressure drops are often responsible individually or together. In all cases, however, priming and foaming

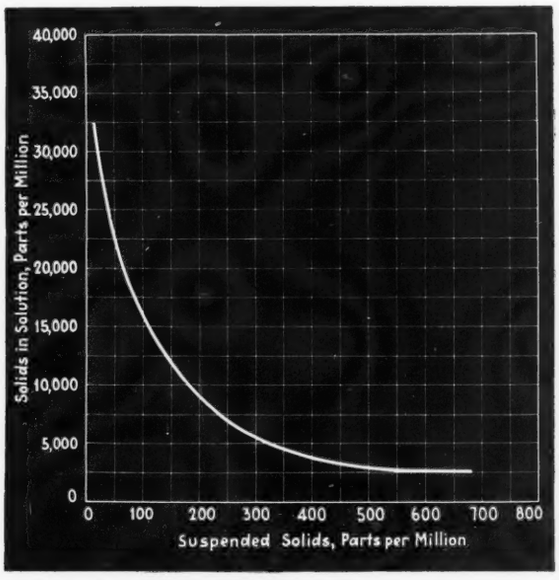



**Fig. 2—Critical concentration value and the relation between dissolved and suspended solids**

are aggravated by or can be traced directly to increase in surface tension of the boiling water brought about by concentration of impurities. These substances stabilize the film surrounding steam bubbles in the boiler water, delaying their bursting. This delay creates a geyser-like action at the water line in the case of priming, or the bubbles fail to break and foaming occurs.

It is easily seen that with modern boilers having steam drums of comparatively small diameters and operated at high ratings, careful control of boiler-water concentrations is needed to avoid carryover.

Impurities in boiler water are either dissolved solids or insoluble material held in suspension. While either form of impurity, if concentrated sufficiently, will produce carryover, combinations of the two having much lower concentration are especially dangerous. There is a critical point limiting these concentrations in any given boiler installation.

The curve of Fig. 2, obtained from tests on a 3000-sq.ft. longitudinal-drum water-tube boiler operating at 200% rating, shows the points at which carryover occurs with varying concentrations of dissolved and suspended solids.

Soap or other organic matter in boiler water is particularly undesirable. These substances which enter the boiler through contamination of the feedwater supply by certain types of engine oil or sewage often produce foaming, even though present in very small quantities.

Consideration of these causes of carryover indicates control of boiler-water concentrations as the first step in any elimination program. This control involves three factors, removal of impurities from the feedwater, preventing concentrations from exceeding the critical limit, and maintaining an economical balance between the quantities of dissolved and suspended solids.

Removal of impurities from feedwater is especially desirable when oil, soap or organic matter cause trouble. Oil can usually be eliminated by properly designed separators. In bad cases, however, it may be necessary to filter the feedwater. Water containing soap or organic matter must be filtered. Chemical coagulation before filtration is often beneficial. External softening of boiler water is often economical. Zeolite softeners, while they do not reduce the total mineral solid content of the feedwater, do reduce insoluble solids to a minimum, thus decreasing the quantity of suspended matter in the boiler water.

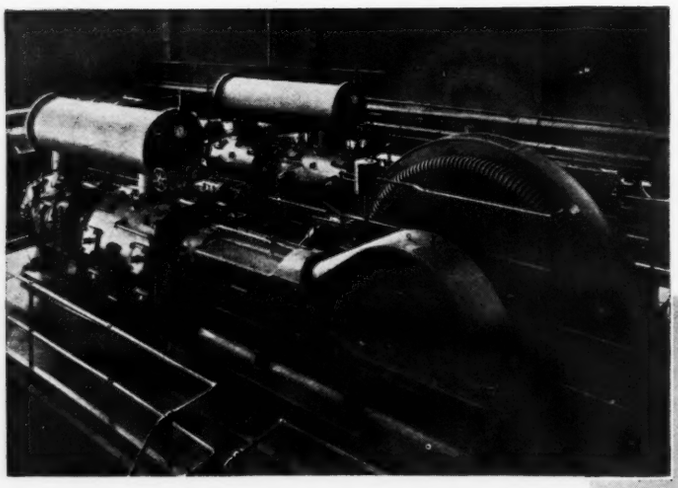
Lime-soda softeners reduce the total quantity of solids and slow down the building up of concentrations in the boiler.

Concentration control within the boiler requires that impurities be held below the critical valve by blowing-down the unit either periodically or continuously. Various types of chemical coagulants are also used to throw solids out of suspension in a form easily removed through the blow-down.

Method of handling the boiler is an important phase of carryover prevention. Water levels in the drums must be held as nearly constant as possible, preferably with feedwater regulators. High-water levels bring steam-liberating surfaces close to the boiler outlet nozzles, thus promoting entrainment. During light-load periods, water should never be permitted to rise past the middle gage cock. Sudden opening of a steam valve or erratic pressure control may cause carryover by quickly flashing large quantities of steam, lifting the water, and producing very violent boiling.

There are many cases where carryover still persists, even though all ordinary preventative measures are used. To reduce entrained solids to an absolute minimum, steam washers or steam separators are installed. Washers use the relatively pure incoming feedwater to wash outgoing steam. Separators remove entrained water and solids by impinging the steam against baffles or suddenly changing its direction of flow so that foreign particles are thrown out by centrifugal force. Separators or purifiers are also valuable as insurance against any unexpected slugs of water which might damage power-plant equipment.

# Motors for Air-Compressor Drives



*By M. N. Halberg*

*Industrial Department,*
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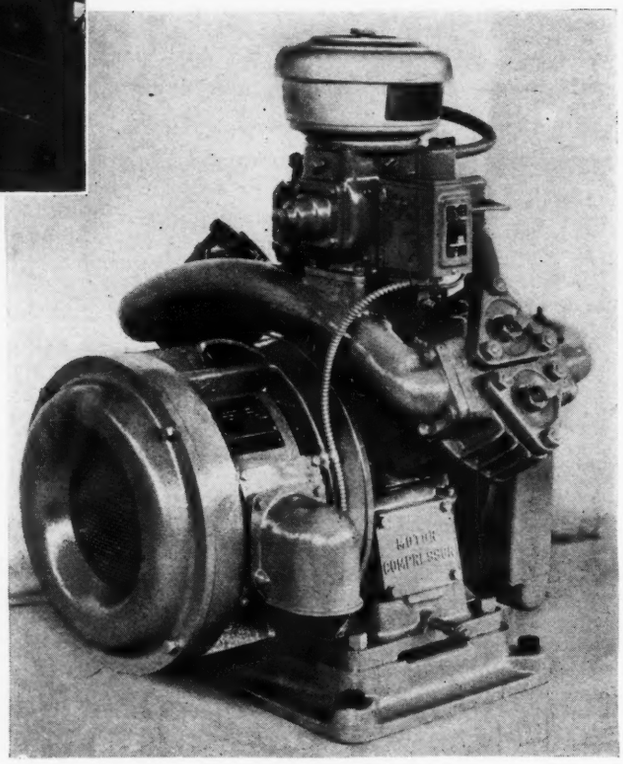


**Characteristics of d.c., single-phase and polyphase a.c. motors for driving air compressors, and conditions where each is suitable**

**Fig. 1—A 1,000-hp., 133.3-r.p.m., 10,000-volt synchronous motor mounted directly on the shaft of a large double, tandem-compound air compressor.—Fig. 2—Polyhase squirrel-cage induction motor directly mounted on air-compressor shaft**

WHERE A CHOICE exists, polyphase alternating-current power would normally be selected for a motor-driven air compressor. Many air compressors are installed, however, where only single-phase power is available, and others where only direct current can be obtained. Thus each of the three general types, single-phase a. c., polyphase a. c., and d. c. motors is employed.

In general, the use of motors on single-phase power circuits is limited to those of 5-hp. capacity or less, although in particular cases 7½- or 10-hp. sizes are used. In the smaller sizes, 0.25- to 0.75-hp. maximum, 110-volt motors connected to the 110-volt lighting supply are suitable. Large-size motors must be designed for 220-volt operation, and separate incoming lines provided from the 220-volt distribution system. Motors operating at 1,725 r.p.m. are usually employed with the speed reduction obtained through flat belts and pulleys, or multiple V-belt drives.

Single-phase induction motors do not develop any starting torque unless provided with an auxiliary starting winding or phase-shifting device. In the repulsion-start induction and repulsion-induction motors commonly used on air compressors, starting is done by a commutated rotor winding which is similar to the armature winding of a d.c. machine. Brushes on the commutator are short-circuited so that the motor starts as a repulsion motor. In the repulsion-start induction motor, a centrifugal mechanism short-circuits the commutator segments as the motor accelerates, thus converting the rotor winding into a conventional squirrel-cage design. The repulsion-induction motor has a separate squirrel-cage winding designed for high reactance so that

its effect is negligible until the motor is up to speed. Thus both these motors start as repulsion motors, and run as squirrel-cage induction motors.

Repulsion-start induction or repulsion-induction motors are generally available in sizes from 1/6 to 10 hp. Their features are low cost, high starting torque (225 to 300%), and low starting current, which make them well suited for air-compressor drive, high starting torque being essential where the compressor starts under load.

Capacitor-type, single-phase motors are being used increasingly in recent years, particularly in fractional-horsepower sizes. This motor has a simple squirrel-cage rotor winding and essentially a 2-phase stator winding, with the capacitor connected in series with one of them. The latter serves to produce the shift in time phase between the currents flowing in the two windings, approaching the relation in a true 2-phase motor. In the smaller sizes, an intermittently rated starting capacitor only is provided, disconnected by a centrifugal switch as the motor comes up to speed. In the larger sizes, a continuously rated running capacitor serves to improve the running efficiency and power factor of the motor as well as to make it self-starting.

Advantages of the capacitor motor are: simplicity, low maintenance, high efficiency and power factor and quiet operation. This motor can also be designed for high starting torque with moderate starting current, suitable for starting the compressor under load. In the past the principal objection to capacitor motors was their somewhat higher cost compared to the repulsion-start induction or repulsion-induction motor. Improvements in their design are gradually eliminating this objection, and a much wider use of this type may be expected in the future.

### Small Compressors

For small- and medium-sized compressors, about 50 hp. and below, high-speed, squirrel-cage induction motors with flat belts or multiple V-belt drives are most commonly used. If the compressors are unloaded when starting, either normal-torque, normal-starting-current squirrel-cage motors, or normal-torque, low-starting-current squirrel-cage motors are satisfactory. Either full-voltage or reduced-voltage starting equipment may be used. Where compressors are started under load, high-torque, low-starting-current squirrel-cage motors with full-voltage starting equipment are required.

Occasionally the wound-rotor-type induction motor is employed. It offers the advantages of high starting torque with low starting current. With a secondary resistor designed for continuous duty, this motor can operate down to 50% normal speed. Its efficiency, however, is reduced in proportion to the speed reduction, so that regulating capacity by this means is seldom economical on constant-torque loads such as reciprocating air compressors.

Multi-speed squirrel-cage motors which operate at two or more fixed speeds are also available. These employ a stator winding which can be reconnected by a controller to secure either full speed or half speed, or they are provided with two or more windings in the same slots, which will give two or more fixed speeds, determined by the number of poles. Because of their low cost, high efficiency and simplicity, standard, single-speed, squirrel-cage motors are more economical for most applications.

Until recently, reciprocating air compressors operated at rather low speeds (400 r.p.m. or below), hence could not be economically driven with direct-connected induction motors. Several manufacturers have now developed a line of high-speed compressors operating at 720 or 900 r.p.m., which are frequently driven by direct-connected, squirrel-cage induction motors. The motor rotor is mounted directly on an extension of the compressor shaft, and the stator frame is bolted to the compressor frame. This construction gives a self-contained, compact, and efficient operating unit, Fig. 2.

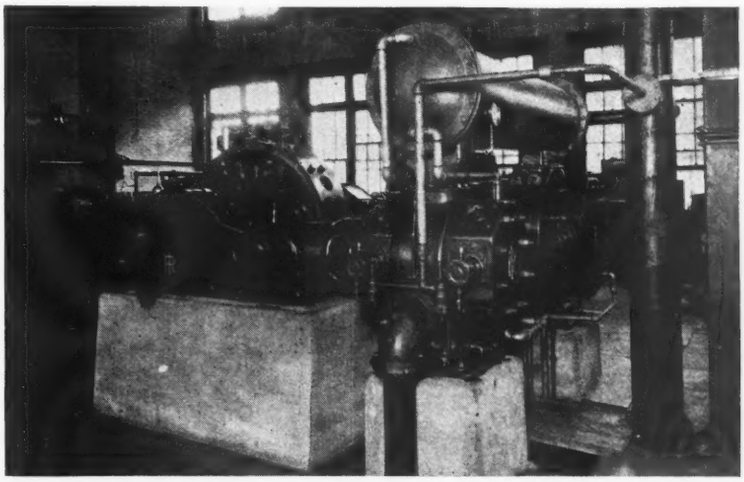


Fig. 3—Low-speed d.c. motor mounted directly on the shaft of an air compressor

Large industrial compressors are usually driven by direct-connected synchronous motors, as in Fig. 1. This drive possesses the advantages of small space, elimination of belts and pulleys, high efficiency, and unity or leading power factor operation. The motors are usually furnished without shaft or bearings, the rotor being mounted on the compressor shaft. A completely split rotor is frequently used to allow convenient assembly. On the smaller compressors, the rotor is often overhung on a compressor-shaft extension, or an outboard bearing may be provided. On a 2-cyl., horizontal, duplex compressor, the motor is mounted on the compressor shaft between the two cylinders, Fig. 1.

Standard low-speed synchronous motors which develop 40% starting torque are satisfactory for practically all air compressors that are unloaded during the starting period. A pull-in torque of 20 to 30% of full-load torque and a pull-out torque of 140% is satisfactory. These values are met by standard low-speed synchronous motors.

It is not economical to use a direct-connected synchronous motor which has sufficient starting and pull-in torque to start a loaded compressor. If automatic operation is required, provide automatic-un-

loading equipment so that a normal-torque synchronous motor may be used.

When applying direct-connected synchronous motors, a flywheel must be provided to limit line-current pulsation, caused by inherent torque variations of the compressor. Excessive-current pulsations produce voltage fluctuations that may cause flickering of lights supplied from the same circuit. High-current pulsation also has a tendency to loosen motor windings and to increase the motor losses. A generally satisfactory current-pulsation limit on industrial-power systems is 66% of motor full-load current, although in some installations a lower limit may be necessary. Flywheel effect required to limit the pulsations to a given value depends upon the torque variation of the compressor (crank-effect diagram), compressor speed, and the motor electrical characteristics. Motor manufacturers are prepared

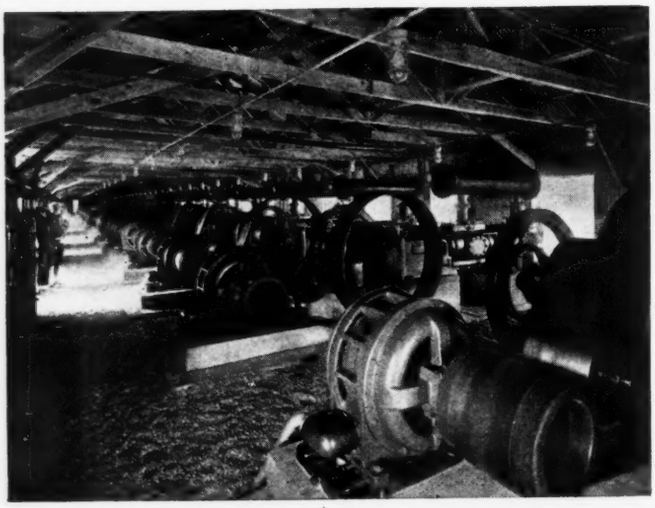


**Fig. 4—Twenty-five 75-hp., 900-r.p.m. squirrel-cage motors driving air compressors through flat belts**

to recommend the size of flywheel required, when given complete information on the compressor. The required flywheel is frequently incorporated in the motor rotor and may need a rotor spider of special heavy construction with rings bolted to its rim.

### Direct-Current Motors

Direct-current motors for air-compressor drive should be of the compound-wound type. For the small- and medium-sized units, high-speed motors with flat belts or multiple V-belt drives are usually more economical, while for large compressors direct-connected low-speed motors are generally employed. In the latter case, a machine furnished without shaft or bearings, and arranged for mounting directly on the compressor shaft is often used. Direct-current motors will develop ample torque to start and accelerate an unloaded compressor.

Adjustable-speed d.c. motors are used occasionally for compressor drives. Speed adjustment is obtained by adjusting shunt-field current with a rheostat. A speed range of 3 to 1 or 4 to 1 can be obtained, although at increased cost.

▼▼▼

# Water Cost

**A survey of water-consuming equipment and sources of possible waste resulted in a saving in purchased water. Continued checking of new installations has served to maintain it**

*By C. J. Zetler, Jr.*

*Works Engineering Dept.,*
*Westinghouse Electric & Mfg. Co.*

AT OUR East Pittsburgh plant, the operating engineers decided that the cost of water could be materially reduced by making a survey of all water-consuming equipment. All water used in the plant at this time, with the exception of condensing water for the power plant, was supplied by the local water company. Many departments were already metered directly. Additional meters were installed in the unmetered departments that used considerable quantities of water.

We then started with the largest consumer, the department where plastics were molded, and made a survey of its equipment. Water was discharged from the platen presses at temperatures as high as 120 deg.F. and was run direct to waste. It was decided that this water could be used in the shop lavatories and similar jobs where cold water was not required. Therefore, a 350-g.p.m., 3,400-r.p.m. centrifugal pump was installed, driven through a speed-increaser by a 720-r.p.m. motor, Fig. 2. This drive was selected because only 25-cycle power was available and the 720-r.p.m. motor being on hand.

Water was returned in a line already installed which was shut off from those departments requiring cool water, but it was soon found that more water could be returned than could be used, unless it were cooled. At this time wire-enameling machines were being installed, adajacent to the molded-plastic department, with water scrubbers on their exhausts requiring approximately 200 g.p.m. To supply this water a well was drilled and a pump installed. This water was found to have a temperature of 60 to 65 deg. F. As the scrubbers did not require particularly cool water, it was decided to install a heat exchanger and bypass part of the reclaimed water from the moulding presses through it and thence back to the presses. Well water going to the scrubbers was passed through the heat exchangers, to absorb the heat from the press water. This made a very satisfactory setup, and all water return from the plastic presses could be utilized. We would have used the well water directly to cool the platen presses, but its mineral content was very high and precipitated at

# Reduced 40%

temperatures obtained in the presses, soon plugging them with scale.

At the opposite end of the works, a number of water-jacketed vacuum pumps were used on process equipment. The water ran to waste after passing through the jackets, its temperature not being raised sufficiently to make it unsuitable for other operations. A 100-g.p.m. motor-driven, centrifugal pump, controlled by a float switch, was installed, together with a tank for collecting the water, to return it to the shop main. Part of it then passed back to the water jackets and part went to other departments.

A survey was then made of the marble and slate grinding and cutting departments, where large quantities of water were used to cool saws and grinders. This water could not be recovered for other purposes without considerable expense, as it was practically saturated with the grindings from marble and slate. In this location the ground has a good water-bearing strata about 30 ft. under the surface and it was decided that well water would be the best solution. A well was dug and a pump installed that provided more water than required, and we piped the surplus to quench and rinse tanks in other departments to replace purchased water.

In other departments, many water-consuming devices were checked, costs of reclaiming water estimated when the savings warranted the necessary expenditure, equipment was installed for this purpose. In several cases, it was found impracticable to reclaim water for other uses because of the cost of installing piping to departments that could use the water. In these places cooling towers were installed, together with necessary collecting reservoirs and pumps to return it to the water-consuming equipment. Both forced- and natural-draft cooling towers were installed.

At an isolated power house, water from the local water company was used in air-compressor jackets and for cooling bearings on an induced-draft fan on a boiler, the return from each going to a tank from which it was pumped for ash sluicing. Only approximately half of the water returned from the air compressors and bearings was required for sluicing, the balance overflowing to waste. A well to supply this water was drilled, as none of the water was required for boiler makeup, but it produced only about half the amount required. As the water was considerably colder in summer than we had been using, it was found that the discharge from the air-compressor jackets could be connected to the inlet of the bearings, the water then passing to the storage tank for ash sluicing.

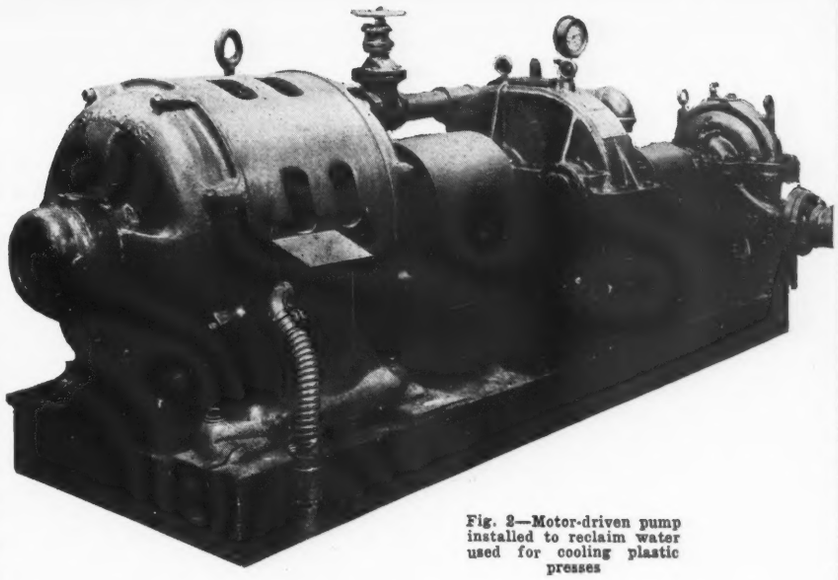
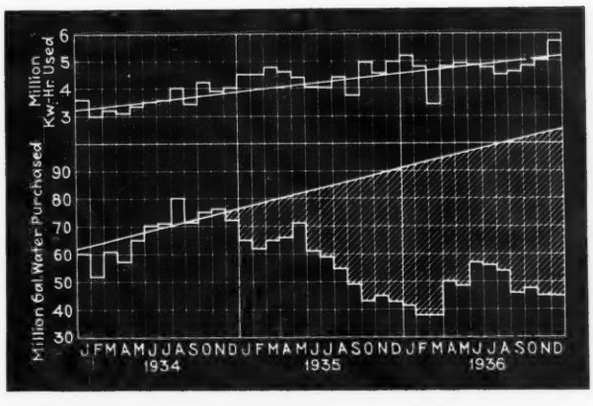


Fig. 2—Motor-driven pump installed to reclaim water used for cooling plastic presses

In Fig. 1, kilowatt-hour load of the plant during 1934, 1935, and 1936 is shown by the upper uneven line, and the average trend by the straight line. The lower uneven line shows actual water purchased and the straight line the assumed increase based on electric-power consumption. It seems reasonable to assume that water consumption would increase in fairly close ratio to the electric power, the shaded portion then represents the savings made in the amount of water purchased, which represents approximately 40% of the total used.

Fig. 1—Chart showing water savings based on increase in kilowatt-hour load

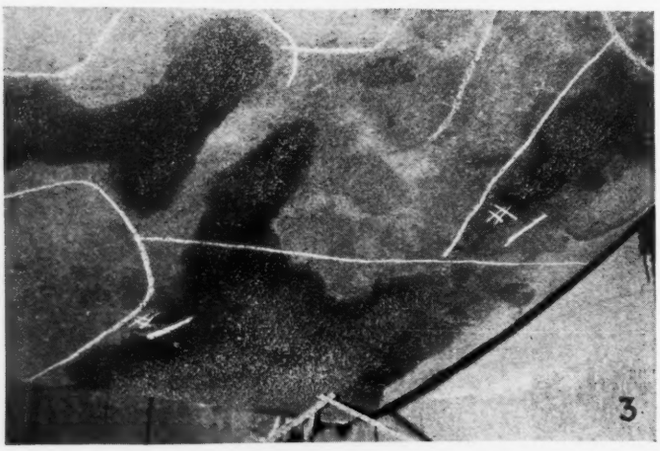



### Water-Main Leaks

Practically all water mains are underground, from 3 to 10 ft. As many of them are as much as 40 yr. old, leaks develop from time to time. To prevent loss of an excessive amount of water from these leaks, a check is kept on water passing through the incoming meters. When an increase is noted, the cause is ascertained if possible. Where no increase in consumption can be found, a check is made on the underground system at the earliest possible time that water can be shut off. These checks are made by closing all distribution piping from the main, isolating the suspected section and then metering the water required to maintain operating pressure on it. Semi-annual checks are made on all underground piping, and a few small leaks are usually located that would not show up on the regular running check of the incoming meters.

With air-conditioning of parts of the plant now being placed in operation and prospects of numerous other installations in the near future, practically all of which use cooling water to condense the refrigerant, it will be necessary to provide large quantities of water at low cost. Each installation will have to be carefully studied, and most economical use made of the water if the cost of operating these systems is to be kept at a minimum.

# Safe Harbor Welding Experience—I



*By P. M. Hess*

*Station Superintendent,*
*Safe Harbor Water Power Corp.*

**Here is the method used in welding pitted areas on four 42,500-hp. turbines with stainless steel. This article describes preliminary studies, safety precautions taken and repair procedure. A second article outlines welding procedure and gives cost of doing the work**

AT THE TIME of building the Safe-Harbor plant, Kaplan turbines were installed that had approximately 8 times the capacity of any previously built in the United States, and of somewhat greater capacity than any in existence. Because of the high operating speed (specific speed) of these runners and corresponding high water velocities, it was expected from the experiences of other companies that pitting caused by cavitation would occur in local spots at an early date. The first two units went into commercial operation in December, 1931, followed by two more in January, 1932.

After about three months of operation, some pitting appeared on the leading or entrance edge of the blades near the periphery. As installed, the entrance edge of all blades was comparatively blunt, and it appears that this set up turbulence and created a void 2 or 3 in. back from the leading edge. This caused pitting, which increased in severity near the outer diameter where higher water velocities are encountered. Fig. 1 shows pitting resulting from cavitation on the bottom side of one blade, after approximately six months of operation.

In July, 1932, these pitted areas were chipped to solid metal, welded and then reshaped to give the entrance edge more streamlining, Fig. 2. Because of the short outage available and lack of experience with stainless steel, ordinary mild-steel welding rod was used. After about one year these welded areas started to pit again, but to a much smaller extent and volume than originally. This indicated that sudden changes in curvature and roughness must be avoided in this type of turbine to prevent local cavitation.

In 1933, after approximately eighteen months of

**Fig. 1—Pitting resulting from cavitation on the bottom of one blade after about 6-mo. operation. Fig. 2—Pitted area chipped to solid metal and welded and the edge of blade rounded. Fig. 3—Pitted area on bottom trailing side of blade after 18-mo. operation. Fig. 4—An enlarged section near the trailing tip, Fig. 3.**

operation, it was found that the bottom trailing side of the blades near their periphery had pitted severely, over an area of approximately 4 sq.ft., on the four units then installed, Fig. 3. An enlarged view of the section near the trailing tip of Fig. 3 is shown in Fig. 4. Several of the holes in this blade are almost 0.5 in. deep, some caused probably by sand in or porosity of the casting. This experience prompted a comparatively elaborate welding program for the low-flow season of 1933.

From experience in welding cast-iron runner blades with stainless steel in Holtwood plant of the Pennsylvania Water & Power Co., it was decided, if possible, to weld all pitted areas on the Safe-Harbor runners with a 18-8 stainless steel (18% chromium, 8% nickel). The Holtwood work was described in "Prevention of Pitting in Water Wheels," by T. C. Stabley in the N.E.L.A. *Bulletin,* September, 1932. To determine if the Safe-Harbor runners could be welded, 2x6x12-in. blocks of steel, with the same specifications as that of the runner blades, were purchased from one of the companies who made castings for them. On these test blocks, trials were made with various types of stainless-steel rods, for flat, vertical, and overhead welding to determine the depositing characteristics of the wire, its bonding ability to the parent steel, shrinkage tendency, current and voltage settings required, ability to chip the pitted areas, machining and grinding characteristics of the deposited metal and types of grinding wheels and grinding tools required to resurface welded areas.

During this experimental period, ability of the maintenance men to weld was determined and effort made to train a sufficient number to do the work on a 24-hr.-day basis. Experience gained in Holtwood plant, together with the assistance of men who had welded stainless metal overhead for several years, plus the help of manufacturers' representatives, resulted in a competent, trained crew of men ready to start the job when the low-flow season arrived. It was found that studding of the pitted areas was not required and that the problem would be comparatively simple compared to welding cast-iron runners. Since practically all of the pitting was on the bottom side of the blades, training was concentrated on overhead welding, Fig. 5.

From results of these tests, welding rods, grinding wheels and chipping hammers were selected for the initial job. This selection, through experimentation, proved valuable and required only minor changes from time to time as better technique in welding, chipping and grinding was developed and superior materials obtained.

Providing scaffolds, approaches, ventilation, and everything necessary for comfort and safety of the men involved is the first requirement in a major job of this nature. A scaffold was, therefore, assembled beneath the turbine runner, so arranged that the distance of its surface from that of the blades could be easily adjusted. In the scrollcase outside the turbine gates, a platform was erected to serve as a small shop for storing equipment, sharpening chisels and doing other work.

An effort was made to provide everything practical for the safety and comfort of the workman. Fig. 5 is a typical view of a welder equipped with safety clothing. Coat and gloves are chrome leather. Extra heavy-duck, fireproof aprons protect the welder's legs and feet. The electrode holder is light and its lead is light and extra flexible to reduce fatigue. The welding helmet is of the head-shield type, thus permitting freedom of the left arm to steady and relieve the normal welding arm. All tools, except for welding, are air-operated to eliminate the accident hazard with electrically operated tools. Fire extinguishers, oil lanterns, 32-volt extension cords, electric fans and flood-lighting are provided as safety precautions and convenience.

Men operating grinders had difficulty securing goggles which would not fog. Trials were made on practically every type available, with no material improvement. This problem was solved by equipping a normal welding head-shield with a window of clear safety glass. The glass does not fog, the shield is more comfortable than any goggles tried to date, and provides additional safety. Shields of this type, Fig. 6, can now be purchased.

A comparatively large blower-type ventilating fan

**Fig. 5—Welder at work on overhead welding; note convenience of protective equipment. Fig. 6—When doing overhead grinding, the operator wears a welding helmet with a clear safety-glass eyepiece. Fig. 7—Method of distributing heated air for heating turbine pits when welding in cold weather.**

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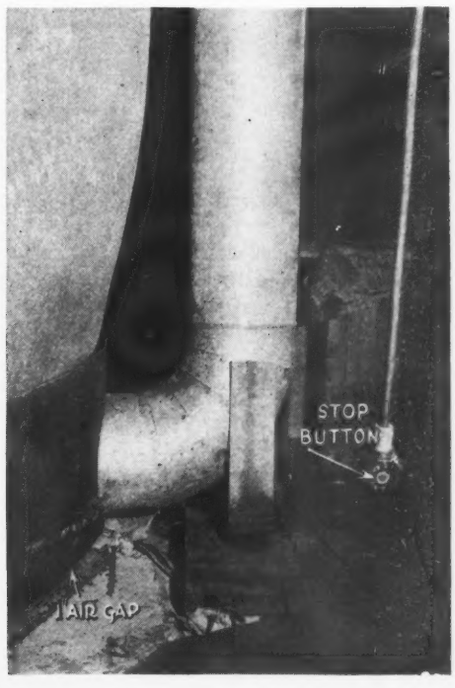


is installed, bringing fresh air from the generator room through an opening in the head cover to the working area. A stop button is provided for shutting down the fan in case of a fire, Fig. 7.

When necessary, the turbine area was heated by blowing the ventilating air through a fin-type steam-heating unit and then distributing it over the scaffold floor so it does not produce an appreciable draft, Fig. 7. One unit was welded in February, 1934, the welder working in comfort at all times. Welding has been done each year since 1932 without a single lost-time accident.

To be able to change blade pitch, as can be done on these units, simplifies the welding work. It allows the angle of the surface to be reduced, from directly overhead to approximately 30 deg. to one side, and provides approximately 5-in. clearance between the throat ring and the trailing periphery of the blade, while at the no-load or horizontal blade position the clearance is only 0.25 in. The larger clearance facilitates welding of blade edges.

The first procedure in welding is to chip out all pitted areas down to sound parent metal, Fig. 9. After chipping, deep spots are first filled level with a mild-steel welding rod, then ground slightly to secure better application of the stainless rod. When all holes in the pitted area had been filled level and ground, the stainless rod was applied. Mild-steel rods were used only because of the saving in cost for filling the holes.

After a chipped-out pitted area is welded, a heavy-duty grinder forms the surface to the original contour of the blade, Fig. 6. Grinding to contour is accomplished by the use of templates provided for various blade sections. When the surface has been formed to an approximate true contour a flat face or polishing grinder is used, Fig. 8*D*. This process tends to produce a more uniform surface and finally a smoother job. Good overhead grinding jobs can be accomplished, without undue delay, only through the use of proper grinder supports and comfortable equipment for the operator.

In the experimental set-up, very little consideration was given to the ability of the workmen to chip out pitted sections properly. When the job was tackled, it was found that this item was really the biggest delay. It is comparatively easy to teach a workman to weld or grind, but chippers of real ability are scarce. Men with many years of experience were borrowed from nearby industries, but in most cases were not able to do a satisfactory job of overhead chipping and could not withstand the fatigue. A man was finally found who seemed to be cut out for this job, having natural ability, was left-handed and developed the logical way to do the job. On the first unit welded, chipping time amounted to 20% of the total man hours. By the end of 1934 this was reduced to 11% and to date amounts to 9½%. A typical chipped surface on a throat ring is shown in Fig. 10. The middle section is chipped to double depth due to the severity of the pitting at this place.

When chipping out a pitted area, a cape tool with a cutting width of about 0.25 in. is used to outline the section to be repaired. Parallel lines of this width separated by approximately 0.5 in. are then chipped with the cape tool across the pitted section. These parallel chipped lines are made at a comparatively uniform depth and serve as the guides or templates for the side-cutting tool which removes the remaining 0.5-in. strips or main body of metal. The side-cutting tool has a cutting face of approximately 0.75 in. A good chipped job reduces welding and grinding time and in the end is the basic cost-controlling factor.

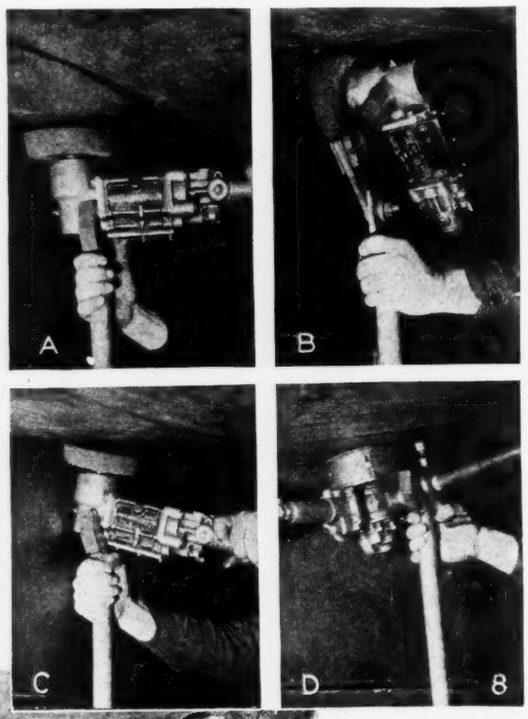



Fig. 8—Application of grinding tools for surfacing welded areas to original contours.

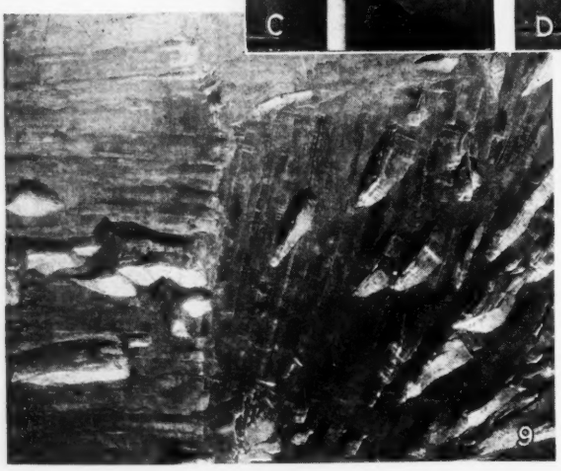
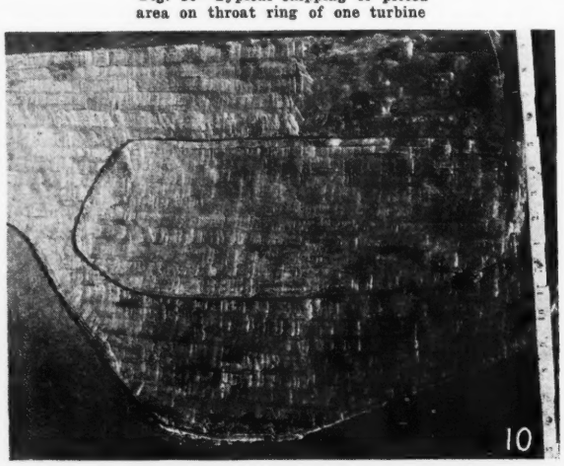


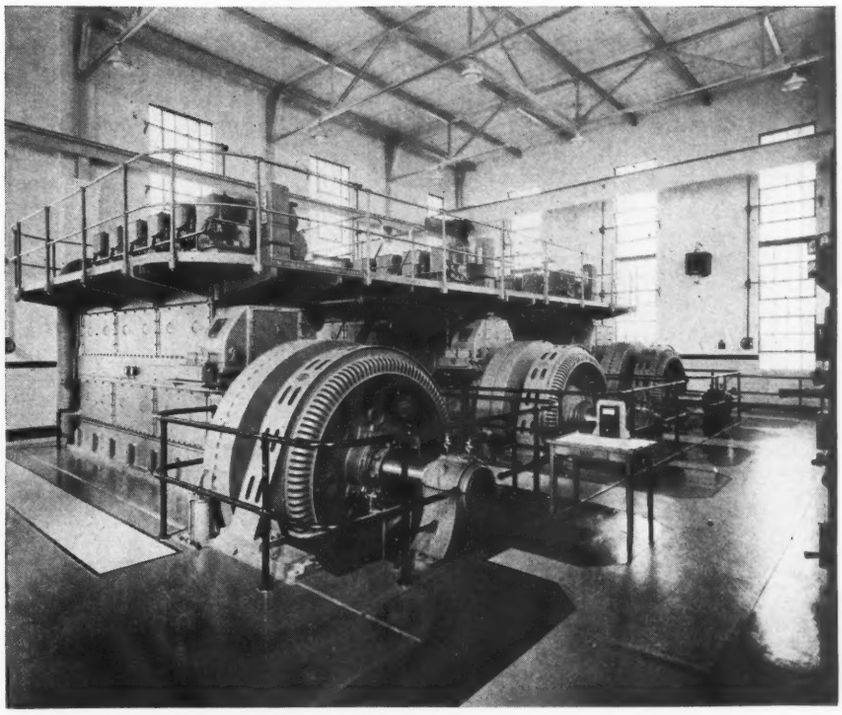

Fig. 9—Pitted area, Fig. 4, chipped out; spots show deeply pitted areas.

Fig. 10—Typical chipping of pitted area on throat ring of one turbine



# How to Use an Indicator—II

**This second article of the series details procedure in taking cards on diesel engines, including full diagrams, draw-cards, and weak-spring diagrams**



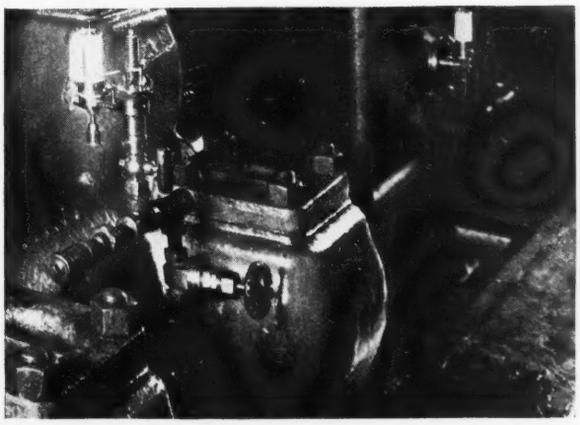
*By Joseph L. Ingram*

*Consulting Engineer*
*Lubrication Department*
*Barnsdall Refining Corporation*

AN ENGINE indicator is the only means of procuring a graphic record of pressure inside the cylinder while the engine is running. Its careful use, plus proper analysis of diagrams, permits an engine to be operated at fullest economy. The diagram can also be used for drawing up a heat balance showing engine heat losses.

After the indicator-drum operating mechanism is set up (*Power,* Feb., page 85), remove the indicator spring and draw a vertical line with the engine at bottom dead center. Then divide stroke into ten equal divisions between top and bottom dead centers, and scribe a line on the indicator card for each. Be sure all lost motion is eliminated before a line is scribed, and mark the crosshead or crank web permanently for each point. This will give 11 vertical lines on the card, which, if they are equally spaced, indicate that the indicator and piston motions are similar. Lines scribed on the crosshead will be useful for reference, while those on the diagram make it possible to measure actual pressure in the cylinder at any time during the power stroke.

Indicators applied to a steam pump. Courtesy A.S.M.E.



Replace the spring and draw an atmospheric line horizontally across the diagram. To do this, unhook the indicator line and revolve the drum by hand. Now start the engine, hook up the reducing motion, check the pencil or stylus, and make certain that the card does not move on the drum. Take the diagram itself, which for a 4-cycle air-injection engine in good condition should resemble the upper card in Fig. 6.

The diagram simply shows the change of pressure during the stroke, and shows the *indicated* horsepower, not that available at the shaft for doing work. Some pressure is used to move the engine and drive its auxiliaries. The height of the line above the atmospheric at any point is a direct measure of the pressure at that point, the ratio of that height to the actual pressure in the cylinder depending upon the strength of the indicator spring. These springs are scaled to raise the pencil 1 in. for each standard increment of pressure, common ratings being 60, 90 and 180 lb. per inch of lift. Normal piston area is $\frac{1}{2}$ sq.in. Pressure range can be changed by changing springs, or by changing pistons and links. Thus, a 180-lb. spring with normal piston will give the same rise on the card as will a 90-lb. spring with a piston of half the area.

On the completed diagram, the area from the atmospheric line to line *C*, Fig. 6, represents work used by engine during compression, while the area above *C* and below *D* and *E*, represents actual work

done by the engine. A planimeter is used in figuring mean effective pressure from the diagram, as it measures area of the diagram automatically. Average diagram height is this area divided by the length of the diagram. (A close approximation to average height can be obtained by averaging the heights of the vertical lines at the equal intervals, between the *C* and *D* lines.) M.E.P. is then determined by multiplying average height in inches by the scale of the indicator spring. This result is used in these formulas:

$$\text{I. HP.} = \frac{\text{PLAN}}{33{,}000} \quad \text{for the 2-cycle engine.}$$

$$\text{I. HP.} = \frac{\text{PLAN}}{2\text{x}33{,}000} \quad \text{for the 4-cycle engine.}$$

These give the power for one cylinder, so the i. hp. for all cylinders must be added to get engine i. hp. In double-acting engines, both ends must be figured. In the formulas, *P* is indicated pressure (average) in lb. per sq. in., *L* is length of stroke in *feet, A* is piston area in sq. in., and *N* is number of revolutions per minute.

### Compression Diagrams

Although an engine may not have set a stroke-reducing gear, much valuable information can be obtained by compression diagrams—in fact, taking such cards is part of the usual routine on large diesel installations. Falling off of compression in any cylinder indicates leaky valves or worn and stuck rings.

Diagrams of this type should always be taken under the same conditions, preferably under full load with the engine warmed up. The indicator is connected to each cylinder in turn, the pencil pressed lightly against the paper, and the drum rotated for an inch or two by hand slowly enough for the lines to come close together. Fuel must be cut off the cylinder being indicated, and where extreme accuracy is desired in air-injection units, injection air must also be cut off. (A compression card can also be taken by turning the engine over with starting air, but most engineers prefer to take cards with the engine running.) Fig. 7 shows a compression diagram for a 6-cyl. engine.

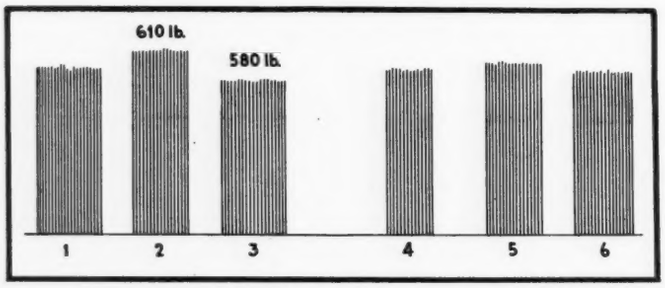



Fig. 6—(Upper right) Diagram from a 4-cycle air-injection engine before and after spray-air valve adjustment.

Fig. 7—(Above) Compression diagram from a 4-cycle engine.

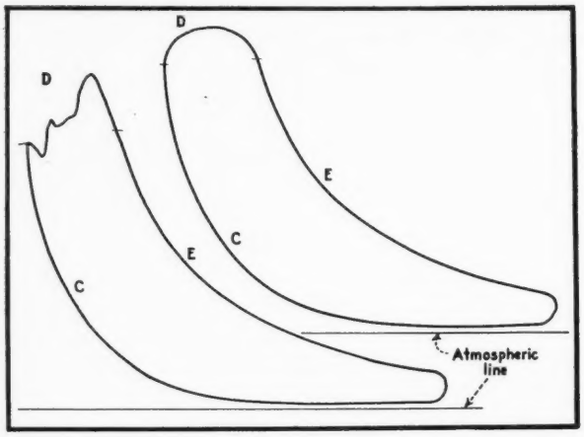
Fig. 8—(Lower right) Draw-cards showing different shapes of firing diagrams.

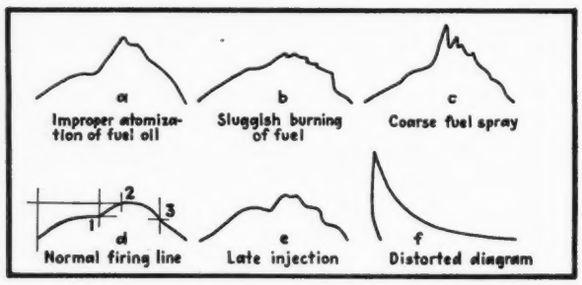
### Exhaust Temperature

Incorrect timing of valves, low spray air, and clogged atomizers will not break fuel up sufficiently, thus causing incomplete burning. Exhaust temperatures are a good checkup on general conditions, and the use of a pyrometer in balancing out various cylinder temperatures is extremely valuable. Many conditions affect the pyrometer readings in the same way, however, but by checking pyrometer temperatures against the pressure diagram the exact cause of the trouble may be determined. Overloading, late injection or low compression all may cause increased exhaust temperatures, but often the overloaded cylinder is not the one at fault—one or more other cylinders are not carrying their share of the load. The remedy is to keep compression pressures as near the point recommended by the engine builder as possible, and to keep exhaust temperatures alike within a few degrees.

### Valves

Diagram shape can be affected by several conditions: mechanical defects in the indicator, engine speed, fuel-oil temperature and viscosity, engine load, spray air pressure, etc. Therefore it is not an exact interpretation, unless the reader is very familiar with the particular engine. Diagrams from one engine can never be used to correct defects in another, even of the same type.




Fuel-injection valves can get out of adjustment easily, resulting in wear or mechanical failure of the injection system. When an engine is operating at, say, 300 r.p.m., and injection is completed in 1/50 sec., extreme care is necessary in valve timing and setting. This depends on action of the fuel pump where direct injection is employed, and on correct valve timing where the cam-operated valve is used.

On smaller engines, usual methods of valve setting are accurate enough on all but the injection valve. Once correct timing is established by a system of markings, there is usually little necessity for changing settings of exhaust, intake or starting

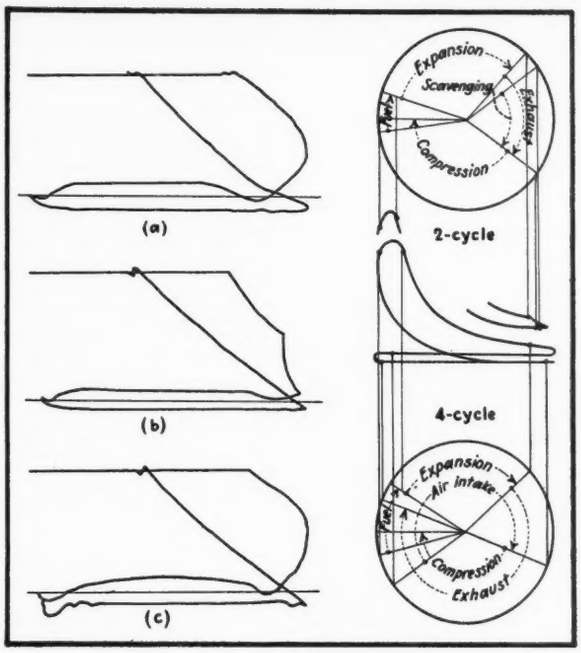



**Fig. 9—(Left above) Low-pressure diagrams.**
**Fig. 10—(Right above) Difference between indicator diagram and valve action on 2-cycle and 4-cycle engines.**

valves. But injection-valve timing must be modified with changes of speed, temperature and fuel, particularly where heavy fuels are used.

Many injection valves are set by a mark on the flywheel, good enough where no one can use an indicator, and better at least than guess settings. But often when injection valves have been adjusted to open at exactly the same time and degree before top dead center, the indicator shows a variation in the combustion line. This requires slight changes in valve setting to distribute cylinder load evenly. Apparently, such differences are due to slight variations in spray air valves, cams, etc., and can be detected only by taking firing diagrams.

With low-grade fuels, I have often adjusted spray-valve position accurately with a micrometer indicator on the valve stem, and then found considerable operating variation in making diagrams. (In the absence of an indicator, the micrometer permits valve adjustment to within a ten-thousandth of an inch.) Cards for adjusting injection valves are often called "pull-cards" or "draw-cards," because the reducing motion is disconnected, the drum being rotated by hand. The pencil is drawn across the card just before the piston reaches top dead center on the compression stroke. Because the card is hand-pulled, the diagram base is inaccurate and represents no known crank angle, but this is immaterial, because the diagram peaks are the important elements. Fig. 8 shows several such cards and indicates what they mean. These meanings are not invariable—they vary with the engine, but the general shapes are somewhat similar.

In *f*, Fig. 8, the distorted diagram shows early fuel admission. Adjustment of injection-valve timing brings the diagram back to the shape *d*, in which the diagram does not peak sharply above the compression pressure. In *d*, the pressure line gradually rises to the final compression pressure indicated by the apex of the first hump, then runs horizontally over the dead-center period at 1. At this point piston speed is slowest and pressure nearly constant. The rise to 2 indicates burning of the fuel, the height of the second hump giving maximum cylinder pressure. Gas volume increases so rapidly due to expansive burning of the fuel that the pressure line holds well up until the piston is well on its downward stroke. This kind of diagram, like most others, should be made with the engine under normal load at running temperature.

### Weak-Spring Cards

Fig. 9 shows the weak-spring diagram which is of greatest use in valve adjustment. On the usual complete diagram, the atmospheric, exhaust and suction lines are so close together that they are indistinguishable. If a weaker spring is used, compression in the 4-cycle engine causes the stylus to rise immediately to the upper limit of its travel until pressure within the cylinder drops below the strength of the indicator spring. At that point the stylus begins to make a diagram toe exaggerated for height, together with the exhaust and suction lines, *a*, Fig. 9. The sweeping action of gases leaving the cylinder causes the expansion line to fall below atmospheric for a short time. Timing the intake valves to open a little before top dead center causes this vacuum to assist in drawing fresh air into the cylinder for the next compression. Diagram *b*, Fig. 9, shows an exhaust valve opening too soon, *c* shows late timing of the intake valve. Fig. 10 compares 2-cycle and 4-cycle engine diagrams.

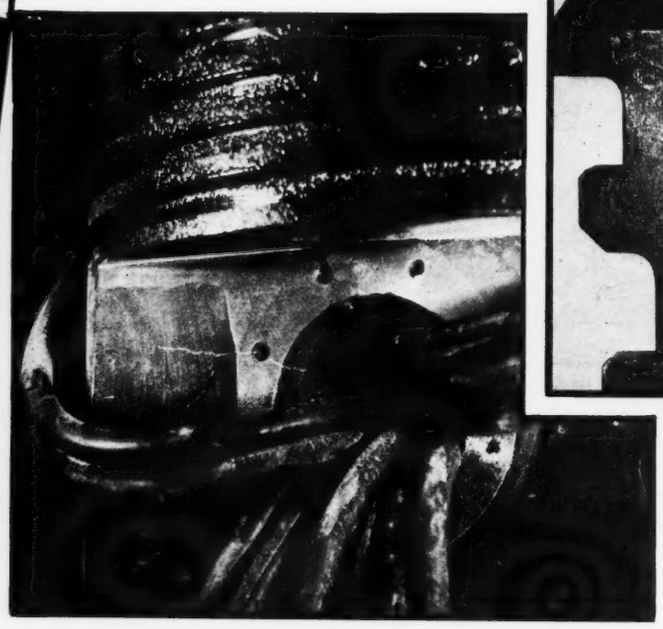
## Rest in Pieces

**There was a young oiler named Adder**
**Who never would anchor his ladder**
**'Til once it came down, split open his crown**
**And he wished like Hell that he hadder.**

**Engineer Swartz from Palum**
**Ignored a corroded mud drum**
**It rusted to doom, went out with a boom**
**And put the whole town on the bum.**

**A young engineer named Salooze**
**Tried to clean out the soot from his flues**
**A quart of good gas, dumped into a pass—**
**Left no clues to Salooze but his shoes.**

*Left*—Solenoid wrapping of cable on turbine shaft to detect cracks and flaws. Wrapping must be carefully done, or the powder merely forms "streamers" standing out from the surface. *Below*—Gas-engine piston, showing fatigue crack which would eventually cause failure. All piston photographs courtesy A. A. Stevens. *Right*—Crack in turbine blade, normally invisible. Such use was first made by Westinghouse in 1929



*Below*—Puzzling hieroglyphics, due to powder collecting on spots at which local residual magnetism has been set up by drawing an iron rod along the magnetized surface. Reversed polarity causes powder to drop off, exposing false indication

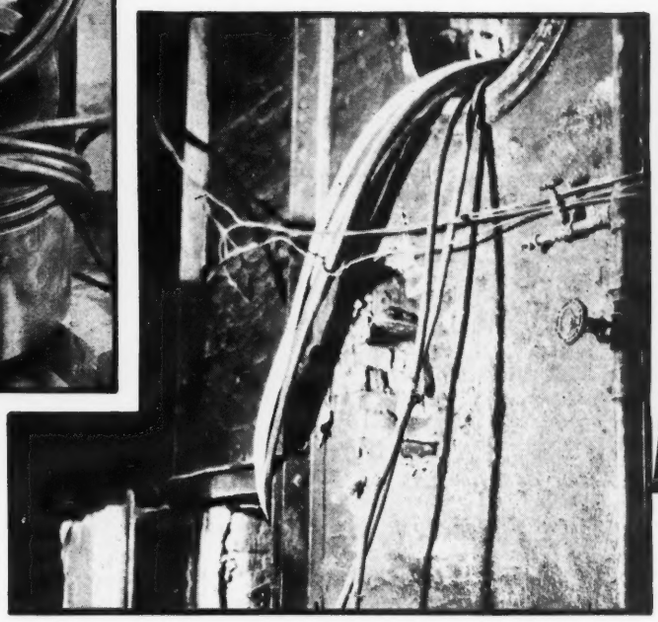
# Crack

MAGNAFLUX, the finely ground iron first used to detect cracks in turbine blading, is now being used even on boilers and pressure vessels. Dusted on with an ordinary plant-spray bulb (see lower right) by combination squeezing and throwing, this powder will deposit on a magnetized surface to form ridges over cracks or flaws, no matter how microscopic or how far below the surface.

Latest developments in the use of this powder were described before a combined meeting of the

Drilled holes of varying sizes and position are faithfully revealed

*Left*—Toroidal winding, producing a closed flux circuit revealing cracks that solenoid winding would not show. *Below*—Winding in two drums at one time by passing cable through circulating tubes and manhole opening of second drum. *Right*—Torodial winding on steam-turbine disk to show radial cracks as well as circumferential ones with a radial component



# Sleuth

New York sections A.S.M.E. and A.W.S. Jan. 13, by R. F. Cavanaugh, superintendent, Engrg. Dept., and Thos. C. Rathbone, chief engineer, Turbine Division, Engrg. Dept., Fidelity & Casualty Co. of New York. These photographs and accompanying data are abstracted from the papers, which appear in full in *Mechanical Engineering* for March.

Before testing, surfaces must be wire-brushed to remove thick scale and sediment. Normally, four or five rivets are taken from each longitudinal seam and two or three from each girth seam to permit checking of holes. A drum or other element is magnetized by winding through it several turns of flexible cable, energized by an ordinary portable electric welding set. Current value is dependent upon size of piece and number of turns of cable, but usually is around 2000 ampere-turns. Winding is normally parallel to the expected direction of cracks, so the magnetic field is at right angles. Even cracks generally parallel to the field, however, usually have enough twists and turns to show up at some place along their length. Where cable winding is impractical or local areas are tested, portable electric magnets may be used.

*Below*—Gas-engine piston defect unknown to present operators, but plugged at some earlier date, then carefully refinished. Plugs may wedge the crack open, and often are set at the visible crack end, while the invisible crack extends beyond

# Cast and Forged Flanges

## —A Study of Comparative Strength and Rigidity


*By Lester Benoit*

*Engineer, Reading Steel Casting Division, Reading-Pratt & Cady Co., Inc.*

*and*

*Raymond L. Collier*

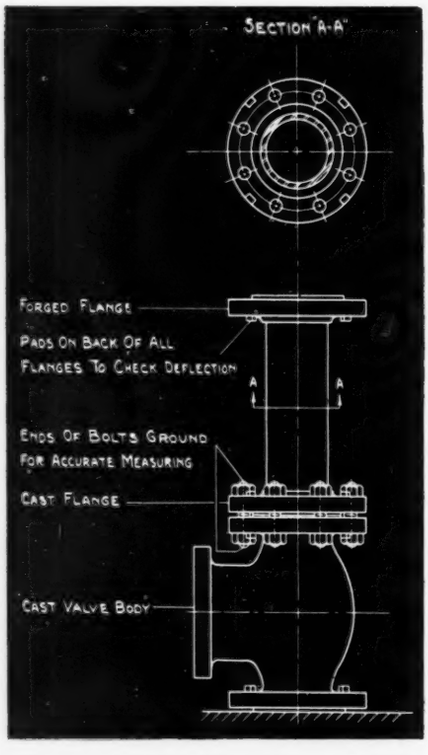
*Secretary, Steel Founders' Society of America*


IS A forged-steel companion flange stronger and more rigid than one of cast steel? Is a flange cast integrally with valve body more rigid than companion flanges bolted thereto? To answer these questions and determine the permanent distortion of these products under mechanical stress, the steel foundry engineering department of a well-known manufacturing company conducted the investigation here reported.

General results were not altogether a surprise, but the relative magnitude of the factors was not anticipated. The tests showed that cast-steel companion flanges varying in size from 4-in. to 8-in. (pipe size) were much less subject to distortion than forged-steel flanges. The forged flanges bent from 60% to 190% more than the corresponding cast-steel flanges. The relative permanent deformations were even more striking, the cast-steel flanges showing practically no permanent deformation, while the forged flanges took a permanent set ranging between 35% and 75% of the total deflection.

Flanges cast integrally with the valve bodies were found to sustain practically no permanent deformation and the total flexion was comparatively slight. As might be expected, the flexion of the valve flanges was greater when opposed to cast-steel companion flanges than in the case of forged companion flanges.

Fig. 1—The testing set-up




Every effort was made to equalize test conditions for both the cast and forged specimens. Three sizes of flanges (4-in., 6-in. and 8-in.) were tested and on all three sizes the method of test was practically the same. The apparatus consisted of a valve body securely bolted to a test bench. (Fig. 1). Four small pads were welded to the back of each flange on the 45-deg. center lines, and back-faced in the boring mill to equal measurement from the flange face.

A nipple unit or filler piece was made up with a forged flange on one end and a cast flange on the other. The backs of these flanges were padded as above described, pads being lined up so that they were exactly opposite each other in the assembled unit. Vertical distance between pads was about 12½ in. Raised faces of all flanges were trued with a light cut to eliminate slight irregularities which would crush under load and give false readings.

The double-flanged nipple was then bolted to the valve-body flange without gaskets by alloy-steel bolts threaded full length. Bolts were ground on both ends to facilitate accurate micrometer measurements. When the cast flange was bolted to the valve flange, the pads on the back of the forged flange were used as reference points, and vice versa.

The joint was first made up hand tight. Dimensions were then taken as follows: (1) space between opposing flange edges, (2) over-all distance between pads on test flanges, (3) length of bolts, (4) distance between pads on nipple filler piece, (5) distance between pads on valve-body flanges.

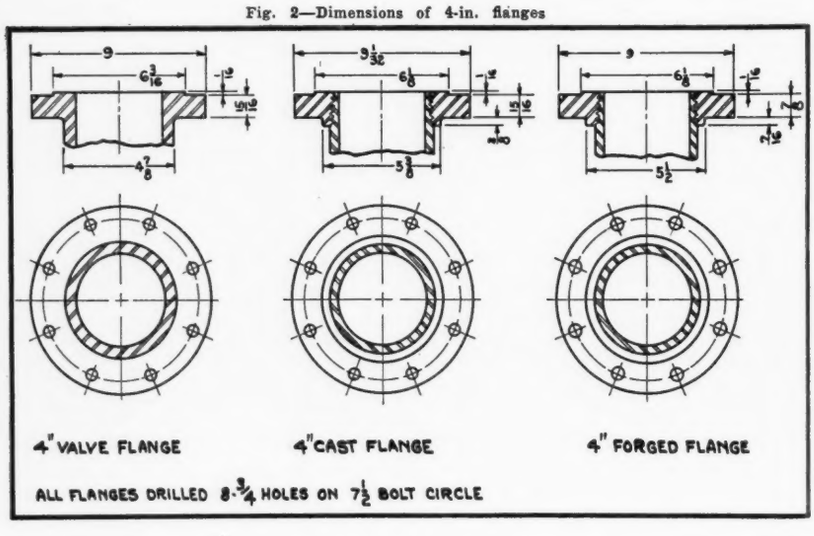
Flanges were then drawn up by turning nuts ¼ turn each, after which readings were repeated. The nuts were then taken up by a series of steps (1/6 turn each), readings being taken after each step. When the bolts stretched excessively or the flanges bent excessively, a final reading was taken, bolts were returned to the hand-tight condition, and measurements taken to check permanent distortion.

Figs. 2, 3 and 4 give dimensions of the flanges. Cast flanges were slightly thicker than forged flanges. However, hubs were slightly higher on the forged flanges. Maximum allowance for this slight disparity was carefully computed as being in the order of 5%, which should be charged against the showing for the cast-steel flanges.

Calculations from the data proved that the dimension from back to back of the valve flanges had to be used as the reference dimension, instead of back to back of the two flanges on the nipple filler piece. The companion flange took a dome shape as the bolts were tightened, the locus of the fulcrum being the outside of the raised face. This naturally raised the reference flange more and more each time the bolts were taken up.

In checking the back-to-back readings on the valve flanges, only two measurements

Fig. 2—Dimensions of 4-in. flanges



could be taken, as the neck of the bonnet flange opening prevented the use of the micrometer between the two points nearest the bonnet flange. The back-to-back reading of valve-flange dimensions was not taken on the 4-in. valve, as it was assumed at the beginning of the test that bending of the valve flange would be the difference between the amount the flanges came together and the amount the back-to-back measurement of the nipple filler-piece flanges increased. This proved to be untrue, as the back-to-back reading on the filler piece increased more than the space between the flanges decreased, thus showing that the flange at the end of the filler piece was moving upward and could not be used as a reference point. However, the back-to-back dimension of the valve flanges was taken on the 6-in. and 8-in. sizes, so that a true story of the deflection on these sizes was obtained. It was noted that the flanges do not bend down evenly, the space at intermediate points being greater than the space at the bolts.

Fig. 5 shows the bending of a 4-in. forged flange bolted to a valve flange compared with a 4-in. cast flange bolted to a valve flange. It also shows the comparative amount the bolts stretched in each case. Figs. 6 and 7 summarize similar tests on 6-in. and 8-in. flanges, respectively.

Tension test bars were cut from both the 8-in. forged and 8-in. cast-steel flanges (two from each). Chemical and physical test results are set forth in Tables I and II.

Fig. 5—Bend test of 4-in. flanges

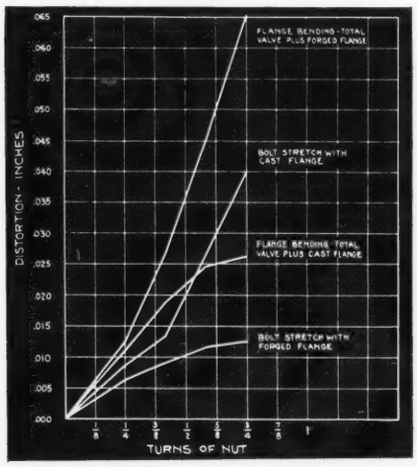

DISTORTION - INCHES
TURNS OF NUT
FLANGE BENDING - TOTAL VALVE PLUS FORGED FLANGE
BOLT STRETCH WITH CAST FLANGE
FLANGE BENDING - TOTAL VALVE PLUS CAST FLANGE
BOLT STRETCH WITH FORGED FLANGE

Fig. 6—Bend test of 6-in. flanges

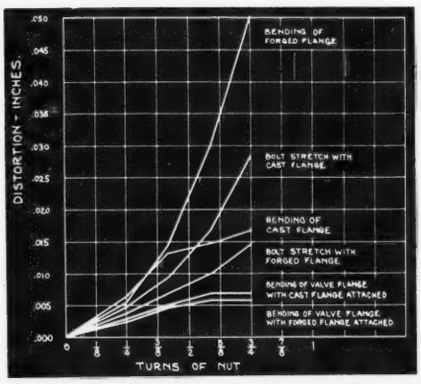
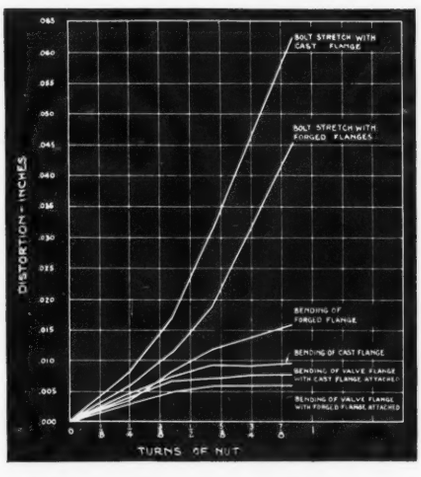

DISTORTION - INCHES
TURNS OF NUT
BENDING OF FORGED FLANGE
BOLT STRETCH WITH CAST FLANGE
BENDING OF CAST FLANGE
BOLT STRETCH WITH FORGED FLANGE
BENDING OF VALVE FLANGE WITH CAST FLANGE ATTACHED
BENDING OF VALVE FLANGE WITH FORGED FLANGE ATTACHED

Fig. 7—Bend test of 8-in. flanges


DISTORTION - INCHES
TURNS OF NUT
BOLT STRETCH WITH CAST FLANGE
BOLT STRETCH WITH FORGED FLANGES
BENDING OF FORGED FLANGE
BENDING OF CAST FLANGE
BENDING OF VALVE FLANGE WITH CAST FLANGE ATTACHED
BENDING OF VALVE FLANGE WITH FORGED FLANGE ATTACHED

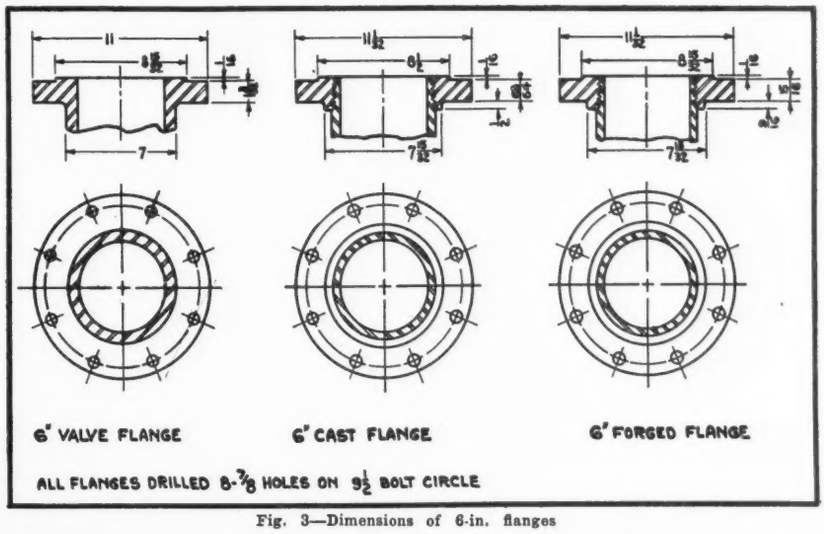



Fig. 3—Dimensions of 6-in. flanges

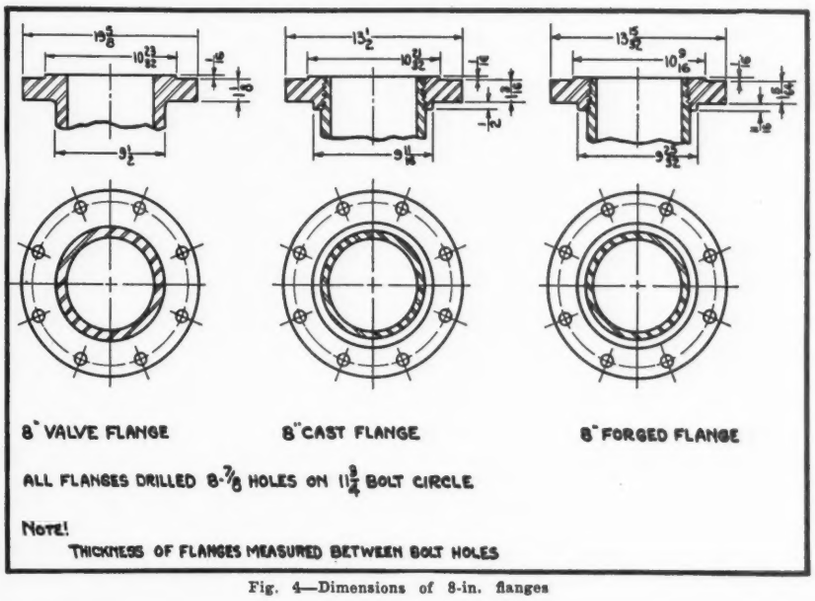

8" VALVE FLANGE
8" CAST FLANGE
8" FORGED FLANGE
ALL FLANGES DRILLED 8-7/8 HOLES ON 11¾ BOLT CIRCLE
NOTE!
THICKNESS OF FLANGES MEASURED BETWEEN BOLT HOLES

Fig. 4—Dimensions of 8-in. flanges

**Table I — Chemical Analysis of 8-in. Test Flanges**

| | Forged-Steel Flange | | Cast-Steel Flange | |
|---|---|---|---|---|
| | Specimen No. 1 | Specimen No. 2 | Specimen No. 1 | Specimen No. 2 |
| Carbon | 0.27 | 0.27 | 0.24% | 0.24 |
| Manganese | 0.63 | 0.63 | 0.77 | 0.77 |
| Silicon | 0.01 | 0.01 | 0.49 | 0.49 |

**Table II — Physical Properties of 8-in. Test Flanges**

| | Forged-Steel Flange | | Cast-Steel Flange | |
|---|---|---|---|---|
| | Specimen No. 1 | Specimen No. 2 | Specimen No. 1 | Specimen No. 2 |
| Tensile strength, lb. per sq. in. | 69,200 | 66,050 | 75,700 | 76,350 |
| Yield point, lb. per sq. in. | 31,750 | 30,100 | 43,200 | 45,600 |
| Elongation in 2 in., % | 24.5 | 20.0 | 22.0 | 22.5 |
| Reduction of area, % | 53.3 | 28.5 | 42.5 | 31.2 |

# Gravity-Type Purifiers for Lubricating Oil

*James I. Clower*

*Assistant Professor of Machine Design, Virginia Polytechnic Institute*

**To reduce bearing wear and increase operating reliability, lubricating oil must be maintained in good condition. Six types of gravity purifiers for doing this job are here described**

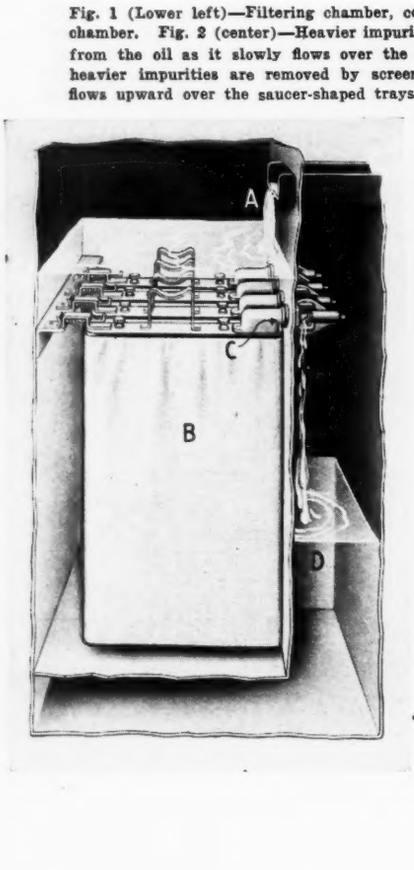
GRAVITY-TYPE purifiers remove impurities from lubricating oil by screening, precipitation, filtration, and washing with water. In general, provisions for performing these processes are incorporated in a single unit.

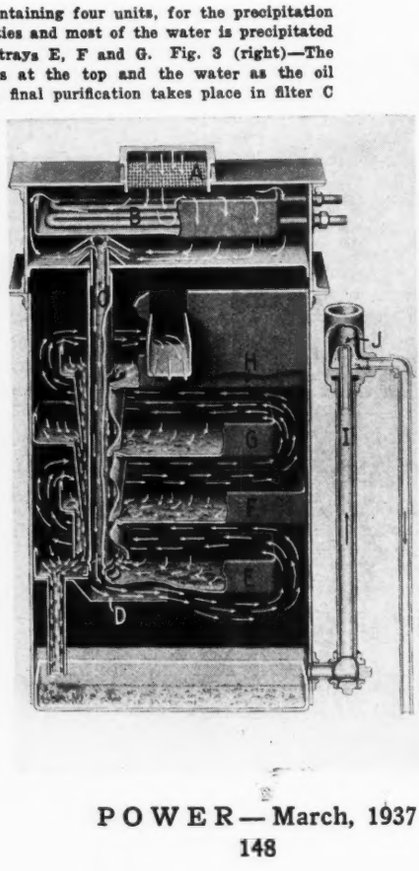
Screening consists of passing contaminated oil through a fine-mesh metal cloth or perforated metal plate. Screening, invariably the first process, removes any coarse, solid impurities that may have gotten into the oil, thereby relieving the precipitation chamber and filtering elements of doing this job.

The precipitation or settling process employs gravity to separate impurities from the oil. Most impurities, including water, are heaver than clean oil and settle out readily. Others, however, have the same or practically the same specific gravity as oil, and cannot be removed by precipitation. The more nearly equal the specific gravities of oil and its impurities are and the more viscous the oil, the greater the time required for separation.

Fortunately, heating reduces both the specific gravity and viscosity of oils, so oil is generally

**Fig. 1 (Lower left)—Filtering chamber, containing four units, for the precipitation chamber. Fig. 2 (center)—Heavier impurities and most of the water is precipitated from the oil as it slowly flows over the trays E, F and G. Fig. 3 (right)—The heavier impurities are removed by screens at the top and the water as the oil flows upward over the saucer-shaped trays, final purification takes place in filter C**



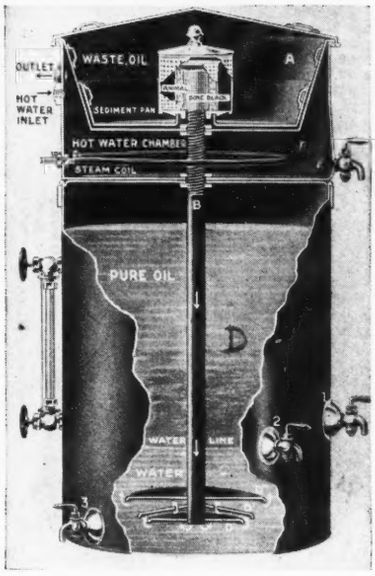



Fig. 4 — Preliminary filtering takes place in the top chamber and final purifying is done as the oil flows up through the water in the bottom of the tank

heated by steam coils or electric heaters to decrease time required for precipitating out impurities. However, more thorough clarification can be had by not heating, provided sufficient time can be given to the process. This is because sludge that is insoluble and would precipitate at the lower temperatures becomes soluble at higher temperatures and will not settle out. Quicker settling, is effected by causing the oil to flow through the precipitation chamber in shallow or thin layers. This is generally accomplished in the purifier by the use of baffles or trays which divide the mass of flowing oil into relatively shallow layers.

### Filtering Elements

All impurities cannot be removed by screening and precipitation, so some other method must be incorporated within the purifier to complete the cleaning. Basically this is generally screening, with fabric instead of metal screens. Some designs use cotton waste, wood wool, felt, excelsior or some other loose material as the filtering medium. Others use a filter bag of special cloth supported by a metal frame.

It is generally desirable to have the filtering element arranged in several units, so that any unit can be removed for cleaning, or be quickly replaced by a clean one without interfering with filtering. When oil contains very fine particles, a large filtering area and a slow rate of flow through the element are required if satisfactory clarification is to be secured. Even with a finely woven cloth-filtering element and a slow rate of oil flow, soluble sludge is not removed to any appreciable extent. It is therefore desirable to pass the oil through at as low a temperature as possible.

Fig. 2 shows one design of a precipitation chamber. *A* is the primary screen through which contaminated oil flows into the filter, then over heating steam coils *B*, thereby reducing its specific gravity and viscosity. Oil then flows down through tube *C* and out over baffle *D*. It next flows upward in a zig-zag course, passing under and over precipitation trays *E*, *F*, *G* and *H*. This is at a slow rate, and oil is divided into relatively shallow layers by the trays.

The heavier impurities and most of the water are precipitated at baffle *D*. Any remaining water precipitates into the trays and is returned to the bottom of the precipitation chamber by funnel-shaped cups surrounding tube *C*. As water accumulates in the bottom of the chamber it is forced to rise through over-flow *I*. Gradually water in this column is overbalanced by oil and water head in the precipitation chamber, and it then overflows at *J* until the two columns are again balanced. Overflow tube *J* can be adjusted for oils of different specific gravities.

### Filtering Chamber

Oil after passing the trays overflows through the trough into the filtering chamber, Fig. 1, completely submerges filter units *B*, then flows through and out clean-oil outlets *C* into clean-oil chamber *D*. When one filtering element is removed, its passage *C* is automatically closed by a spring-actuated valve. This valve automatically opens when the unit is replaced. Pressure forcing the oil through filtering elements is the same at all levels, being equal to the difference in height between oil level in the filter chamber and the outlets *C*, normally about 3 in. This head adjusts itself to the rate at which the filter is being worked. When head is abnormally high, the filter is either being overworked or elements need cleaning, and, an investigation should be made to determine the cause.

The purifier, Fig. 3, is similar to the one in Figs. 1 and 2. Contaminated oil enters through screen *A*, and after passing over heating coils *B* and through screens *C* and *D*, flows into vertical tube *E*. When it discharges from the lower end of this tube the oil spreads out under the bottom saucer-shaped tray, and takes a zig-zag course upward, over and under the other trays, and finally is discharged through pipe *A* into the cylinder filter *B*. It then flows outward through filter bag *C* into clean-oil chamber *D*. Water separated from the oil in the precipitation chamber is automatically removed through the overflow at the left.

Fig. 5 — Small oil purifier using the wet process of purification

This purifier, as well as the one in Figs. 1, 2 and 6 operates on what is commonly termed the dry method of purification, since the oil does not flow through water for washing.

Fig. 4 is a sectional view of an oil filter employing the wet method of purification. In this filter, contaminated oil enters pan *A*, heated by hot water, where the heavy impurities are

precipitated into the sediment tray to relieve the filtering cylinder of this burden. Packed in the filtering cylinder is a small quantity of animal-bone black through which the oil percolates to flow down tube *B*. From the lower end of the tube it flows slowly over filter plate *D* in a very thin layer, the thickness gradually decreasing as flow progresses to the outer edge of the plate. From the edge of this first plate, oil rises to the second plate *D'* by which it is gathered toward the center where it passes through holes to the third plate *D''*, where it is again spread into a thin layer as it flows from the center to the outer edge. This atomizes the oil and exposes it to a washing action as it floats slowly up through the water contained in chamber *D*, which is maintained about one-third full. From chamber *D* clean oil is drawn off through cock 1. Surplus water is drawn off through cock 2, or the purifier may be equipped with an automatic overflow. Any remaining impurities fall to the bottom, and drain to the sewer.

In Fig. 5, contaminated oil passes through washable filtering materials *E*. It then flows down into the precipitation chamber. In this chamber, water and heavier impurities settle out, the oil rising to the top and overflowing through vertical tubes to filter bags *C* and *D* through which it passes to the clean-oil chamber surrounding the bags. Purified oil is withdrawn through cock *B* at the bottom.

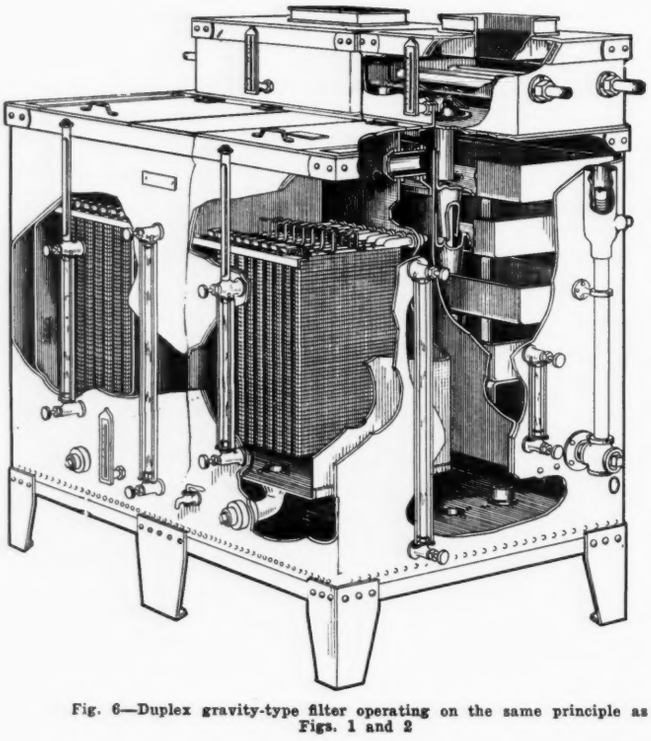


Fig. 6—Duplex gravity-type filter operating on the same principle as Figs. 1 and 2

Fig. 7 shows a small batch purifier especially designed for filtering oil drained from the crankcases of steam and gas engines, air and refrigerating compressors, and drippings from other machinery. Contaminated oil comes in through the basket-type screen into the dirty-oil compartment on the left, where it may be heated by steam coils. After the heat is turned off the oil is allowed to stand in this compartment until water and heavy impurities settle out. This usually requires several days, after which the oil is passed to the filtering compartment by opening the connecting valve. An adjustable float valve automatically controls flow into the filtering compartment and maintains a head from 1 to 6 in. over the filtering units. The oil passes through them into the clean-oil compartment, equipped with a quart self-measuring piston-type pump for withdrawing the oil. A duplex design of gravity filter is shown in Fig. 6, which operates on the same principle as Figs. 1 and 2. This purifier is obtainable in capacities varying from 90 to 1500 g.p.h.

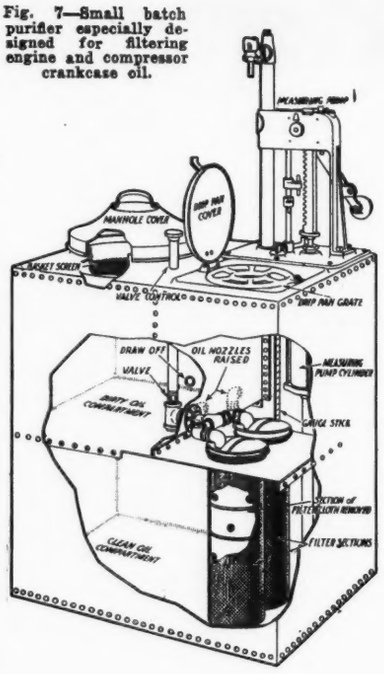



Fig. 7—Small batch purifier especially designed for filtering engine and compressor crankcase oil.

Gravity-type purifiers are suitable for filtering all types of lubricating oils. They are applicable wherever space is available and where they can be free of vibration, rolling and pitching motions, and where the oil is supplied at atmospheric or a very low pressure. They are not suitable for the so-called force-feed systems of lubrication, nor for mobile machinery such as steamships and automotive units. They may be used in bypass, batch-settling, continuous bypass and batch systems.

The author is indebted to S. F. Bowser & Co., Inc., Fort Wayne, Ind.; the Burt Mfg. Co., Akron, O.; Wm. W. Nugent & Co., Chicago, Ill.; and Turner Oil Filter Co., Niles, Mich.; for assistance in preparation of this article.

## Turbines for Tanker

STANDARD OIL CO. (N. J.) has just ordered four 440-ft. tankers from Federal Shipbuilding & Drydock Co., in which steam will be generated by a pair of Foster-Wheeler boilers at 400 lb. at the superheater outlet and 750 deg. Economizer sections are installed but no air heaters.

Geared De Laval turbines have a normal rating of 3,000 shaft hp. at 90 r.p.m. propeller speed. They are cross-compound units with double reduction gears in a single case, the high-pressure turbine running at 6,000 r.p.m. and the low-pressure at 5,000. A Foster-Wheeler condenser maintains 28½-in. vacuum. Boiler feed is heated regeneratively in three tubular heaters. Two De Laval turbine-driven 2-stage centrifugal boiler-feed pumps per ship each deliver 65 g.p.m. against 1160-ft. head at 6000 r.p.m. Boiler feed turbines exhaust to one feed heater against back pressure. The plant is expected to develop a shaft hp. on 0.58 lb. per hr. of Bunker C fuel.

# Before You Select a Paint . . .

*Francis M. Hartley, Jr.*

*National Lead Company*

IN THE PAST few years, many new materials of unestablished value and without much background of experience have been offered to the paint industry, some of which have been introduced into certain kinds of metal protective paint. And they have imparted to these paints new and unusual qualities as well as some doubtful properties. The problem, to get rid of bad and retain good qualities, has led to much experimentation and the introduction of many new paints.

This kaleidoscopic changing of formulas has presented to the buyer a great variety of metal protective paints of varying composition and complex character—all recommended for practically the same purposes. No wonder, then, that the conscientious buyer has become confused and that coatings, more or less incompatible with one another, have had widespread use.

Repainting consists largely of renewing a coating which was applied at some previous time. Composition and age of the old coat will determine behavior and action of the new coat, while composition of the new coat will have a direct effect on its performance when exposed. The element of time is an important factor in the success of a repainting program, as it should be undertaken while the old coating is still in good condition. Notwithstanding scrupulous attention to this detail, the use of paints incapable of chemical or mechanical accord will endanger a repainting program, even though high-grade paints are used.

In order to avoid the use of incompatible paints, due consideration should be given to the following points:

1. Great variations in behavior occur when one kind of a paint is applied over some other kind, i.e., white-lead paint gives good results when applied over itself, but when applied over an asphalt-base paint, results are dubious. Asphalt paint becomes brittle on exposure and is broken away from the surface by the elasticity of white-lead paint.

2. Some pigments are chemically active, among which may be mentioned white-lead and zinc-oxide, which unite with linseed oil to form lead and zinc soaps. Should these two pigments be used together in the same paint, very distinct changes in the physical properties of the paint can be brought about by variation of zinc-oxide content.

3. Other pigments are chemically inert. In general use are silica and asbestine, frequently referred to as extenders, which form no chemical union with linseed oil. They are held in paint film by pressure of the surrounding medium, and affect a dried paint because their presence opens up the film to light.

4. Pigment volume ratio is significant. In a priming coat, the opaque pigment should occupy at least 30% of the dried paint volume. Paint coatings whose pigment oil ratio is less than 30% contain too much oil and hence are less durable and too soft for a base coat.

5. Resins, gums, and even rosin have in many cases been substituted for linseed oil as drying oils. Possible discord may arise from differences in the nature of vehicles present in successively used coats of paint.

6. Poor application and too thick a coat may lead to incompatibility. Thick coatings often do not dry to a solid film, and present alternate ridges and furrows to succeeding coats.

It should not be inferred from any of the foregoing remarks that two different coatings are necessarily incompatible because each one happens to contain a different kind of pigment. Past experience is the best indication of what may be expected from a coating. However, prudence suggests repainting of structures with much the same kind of paint used previously and care in using paints containing resins and oils bodied sufficiently to impart enamel-like qualities until experience clarifies present uncertainties.

It is always desirable to use a coating which is not only durable, but which stands neglect as well. In this respect, lead paints always present a surface that can be repainted easily as they wear way by chalking, a characteristic which prevents building up of a thick film.

The amount of paint restored at each repainting should be practically equal to the amount worn away since the previous repainting. By following this method, coating thickness can be kept within the range of optimum serviceableness.

As it is seldom practical to place a repainting program in the hands of a single paint manufacturer, the paint user must often assume far more technical responsibility than he is prepared to handle intelligently. Hence, there is a real necessity for greater technical knowledge of paint composition, and to gain such knowledge requires conscientious study.

In the meantime, some kind of a generally recognized classification of paints, carefully and accurately prepared by someone who has wide knowledge and experience pertaining to problems involved, is in order and very essential.

# Speaking of Power

It seems to be the expert dope that nothing within reason can prevent 1937 from being a good business year—not even the labor troubles we have had and may have. Such events may dent the varnish some, but can't break the momentum of the chariot of progress—not this year anyway.

1 ..chariot of progress

According to the National Industrial Conference Board, the number of workers in the manufacturing industries averaged 87% of the 1929 number during the first eleven months of 1936. Production volume was 87.3% of the 1929 level. In 1929, the labor requirement was 8,767,000 wage earners, working 48.3 hours per week. Corresponding figures for 1936 were 7,630,000 industrial wage earners and 38.9 hours.

2 ..Russian experiments

I am much interested in the Russian experiments with the underground gasification of coal. The idea is to turn a coal mine into a giant gas producer to save the trouble of mining the black diamonds. . . . There are several ways of operating, the most promising being to use the mine as a water-gas generator. A long air blow brings up the temperature. Then the mine is blown with steam in the reverse direction, producing water gas, consisting of hydrogen, carbon monoxide and some carbon dioxide. . . . The waste gases from the air blow can, of course, be used to make steam in waste-heat boilers, while the water gas from the steam blow can be burned directly under boilers or transported in pipes for city or industrial use. A smart idea; perhaps it will pay.

3 ..Admiral dropped in

Years ago a retired admiral dropped into this office to tell us about his scheme for printing big magazines in a size smaller than a deck of cards and then reading them with a high-power glass. Nothing much came of it for obvious reasons. Folks prefer to read without the help of such contraptions. . . . Yet the micro idea is making headway in an allied field—reference recording. "Science Service" went into it in a big way several years ago, recording full pages of manuscript and bulletins on single frames of standard movie film, and selling them for a few cents a frame. . . . Some libraries now supply such micro copies. They copy anything you want from their shelves or archives. You read the frames through a high-power glass, or project them like lantern slides. . . . The now popular miniature cameras can, of course, be easily rigged to take such pictures; a tip for individuals and companies which go in for filing and recording in a big way. . . . Microfilm copying may eventually solve the problem engineering societies and independent engineering journals face when highly technical research reports are offered for publication. Their editors understand the need of getting these on the record for other researchers and specialists, but don't feel that such material should be inflicted on thousands of readers who have no practical interest in it beyond a brief summary of the results. Micro-film copies could be made for the few who are really concerned. . . . This microfilm technique will suggest another first-class idea to camera hobbyists in the power field. When construction, dismantling, maintenance and repairs are going on, it is a very simple matter, and inexpensive, to record the steps on movie film with a miniature still camera. . . . To identify the film, write a serial number in large black characters on a 3x5-in. card. Put the card in view when taking the shot and thus permanently brand the film. Make any desired notes on the back of the card and file it. . . . It won't be necessary to print any frames except those regarding which some future question arises. Then you can see how things were arranged inside the machine casing, or where that invisible conduit runs.

4 ..brand the film

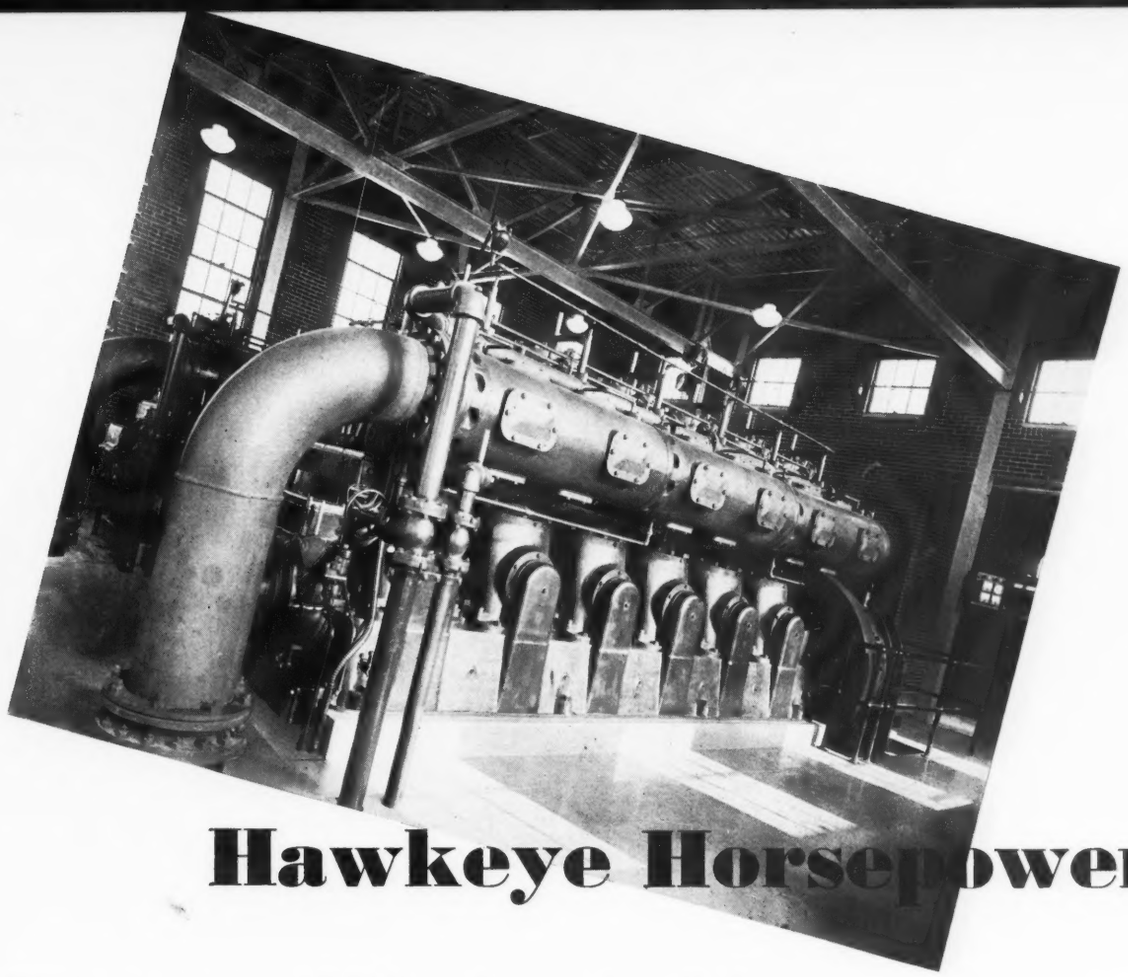
Rightly managed, engineers can get together in a big way. A single N.A.P.E. local (Stevenson Ass'n No 44, New York) recently corralled about 1,500 engineers, wives and friends for its annual reception and dance. That's a crowd. Shows what a combination of moderate price, efficient committee work and a reputation for past performance can accomplish.

5 ..corralled 1500 engineers

Keep an eye out for the next special section—"Combustion Control", in April. Because of the limited number of commercial systems, this will follow an unusual plan. Each system will have a separate article describing its construction and operation in some detail.

I can't close this page without a word about the great floods along the Mississippi and its tributaries. We have many subscribers in the affected areas. By the time they read this they will be dried out and running (we hope). They have our sincere sympathy for great ordeals endured and losses incurred, both at home and in their plants. They have our admiration for a truly American display of resourcefulness in the face of emergency. . . . To help a little, as the flood approached peak, we mailed to subscribers in affected areas reprints of articles showing how to dry out and recondition flooded equipment.

PHIL SWAIN
*Editor*



# Hawkeye Horsepower

**Villisca, Iowa town of 2,100 people, wanted a reliable, quiet, diesel plant, but had limited funds and a poor site. Here the designer tells how all the conditions were met, at $150 per kw. total for a 600-kw. plant**

*By Glenn C. Boyer*

*Associate Engineer*
*Burns & McDonnell Engineering Company*

CONSTRUCTION of a reliable electric-generating plant with diesel prime movers is not an unusual problem today. When it is necessary, however, to design a reliable plant with limited funds on a site that in many respects is anything but ideal, real difficulties are encountered. This plant for Villisca, Iowa, a town of approximately 2,100 population, went into operation Nov. 23, 1936. This site is sloping, adjoining the community water-filtration plant. Approximately 75 ft. separate water-works and power-plant structures. Residences are within 150 ft. It was necessary, therefore, to insure minimum noise and minimum vibration transmission.

Generating equipment consists of two 300-kw. alternators, each direct-connected to a Fairbanks, Morse & Co. 6-cyl., Model 32E, 450-hp., 300-r.p.m., solid-injection, crankcase-scavenging diesel. Cooling water is provided by a closed- or double-circuit cooling system with a spray cooling tower. Raw- and jacket-water circulating pumps are in duplicate. Fuel-oil is stored in two 15,000-gal. elevated steel tanks, providing approximately 3-mo. fuel supply.

The modern brick and steel building has basement walls and floors of reinforced concrete, and a roof of Truscon "Ferrobord" covered with 1 in. of insulation and 20-year bonded built-up roofing.

The engine-room proper is 40x42 ft., with sufficient headroom below the main roof trusses to pull engine pistons, and the lower chord of each truss designed to handle a 5-ton crane. On the front or east face of the building is a stepped section projecting 10 ft. housing the plant switchboard, operating office, and washroom. Because of the sloping site, it was found economical to construct a 50x42-ft. basement under both engine-room, switchboard and office sections.

### Auxiliaries in Basement

Circulating-water pumps, fuel-oil pumps, water softener, compressed-air tanks, air compressors, lubricating-oil rest tank, and lubricating-oil centrifuge are in the basement, as are station auxiliary transformers, under the switchboard. Facilities are also provided for an adequate basement repair shop, 10x25 ft. The operating floor is thus free, with the exception of two small lubricating-oil tanks necessary to maintain correct oil level in the engines.

It was originally planned to use a single-circuit cooling system because preliminary estimates furnished to designing engineers indicated a considerable spread in cost between a single- and a double-circuit cooling system. After further study, we called

# RILEY BRINGS YOU A

# MODERATE SIZE BOILER UNIT

## *complete with fuel burning equipment*

## One Contract—Undivided Responsibility

With the development by Riley of complete boiler units for capacities under 40,000 lbs. of steam per hour, it is now possible for users to obtain units of this size under a single contract without divided responsibility. The proper co-ordination of the boiler and fuel burning equipment is assured and consequently high performance efficiency when purchasing from a single manufacturer.

As Riley manufactures all types of stokers as well as pulverized coal equipment and oil and gas burners, Riley units can be purchased for burning the most economical fuel. In addition to moderate size units as illustrated with capacities from 7,500 to 40,000 lbs. of steam per hour, Riley also manufactures and installs complete larger steam generating units for any desired capacity or pressure.

## *having these distinctive advantages*

### HIGH EFFICIENCY

The design of the Riley Boiler results in the most efficient transfer of heat from the gases to the boiler water, assuring a minimum loss of heat up the stack. This fact, together with high combustion efficiency resulting from the proper co-ordination of boiler and fuel burning equipment, results in unusually high performance efficiency.

### RING FLOW CIRCULATION

Riley Boilers are based on the Ring Flow Principle of circulation which, together with the large height differences between lower and upper drums, assures unusually rapid and positive circulation.

### RELIABILITY AND LOW MAINTENANCE

With rapid positive circulation heat is quickly carried away by the boiler water, preventing tube failures due to overheating. With Riley Boiler, low maintenance and long periods of uninterrupted service are assured.

### WALLS WATER COOLED

The outside tubes of the boiler are arranged to protect the refractory side walls, thereby greatly reducing side wall clinkers and maintenance.

### LOW BRIDGEWALL

Bridgewall areas exposed to the furnace are practically eliminated, the lower portion of the boiler acting as a water-cooled bridgewall. Objectionable bridgewall clinkers and bridgewall maintenance are prevented.

### MINIMUM SPACE REQUIRED

By most effectively utilizing the cubical space, Riley Boilers can be installed where floor space and setting height are limited.

### A FEW TYPICAL INSTALLATIONS OF RILEY COMBINED UNITS

Pet Milk Co., Coldwater, Ohio
1-20,000 lbs./hr.—Riley-Jones Stoker

Pet Milk Co., Delta, Ohio
1-20,000 lbs./hr.—Riley-Jones Stoker

Pet Milk Co., Wayland, Mich.
1-20,000 lbs./hr.—Riley-Jones Stoker

Times Building, Los Angeles, Calif.
3-25,000 lbs./hr.—Oil Fired

German Brewery, Cumberland, Md.
2-37,500 lbs./hr.—Riley Stokers

Charlton Woolen Co., Charlton, Mass.
1-26,000 lbs./hr.—Riley-Jones Stoker

Cumberland Brewery, Cumberland, Md.
2-15,000 lbs./hr.—Riley-Jones Stokers

Worcester Polytechnic Inst., Worcester, Mass.
1-15,000 lbs./hr.—Riley-Jones Stoker

Maryland Tuberculosis Sanitarium, Sanitarium, Md.
1-20,000 lbs./hr.—Riley-Jones Stoker

National Grain Yeast Co., Belleville, N. J.
1-20,000 lbs./hr.—Fired by Oil

N. Carolina State Hospital, Goldsboro, N. C.
1-22,000 lbs./hr.—Riley Pulverizer

Hewitt Brothers Soap Co., Dayton, Ohio
1-20,000 lbs./hr.—Riley Stoker

Owens-Illinois Glass Co., Newark, Ohio
2-30,000 lbs./hr.—Riley Pulverizers

Brehm & Stehle Co., Philadelphia, Pa.
1-30,000 lbs./hr.—Riley Pulverizer

Mercy Hospital, Pittsburgh, Pa.
2-25,000 lbs./hr.—Riley-Jones Stokers

Monroe Silk Mills, Stroudsburg, Pa.
1-15,000 lbs./hr.—Riley-Jones Stoker

Arabol Manufacturing Co., Brooklyn, N. Y.
1-7,500 lbs./hr.—Oil Fired

Forest Products Laboratory, Madison, Wisc.
2-12,000 lbs./hr.—Riley-Jones Stokers

Papec Machine Co., Shortville, N. Y.
1-12,000 lbs./hr.—Riley-Jones Stoker

# RILEY
## STOKER CORPORATION
### WORCESTER, MASS.

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Tacoma Baltimore
St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta

COMPLETE STEAM GENERATING UNITS

BOILERS - SUPERHEATERS - AIR HEATERS - ECONOMIZERS - PULVERIZERS - BURNERS - STOKERS
WATER-COOLED FURNACES - STEEL CLAD SETTINGS

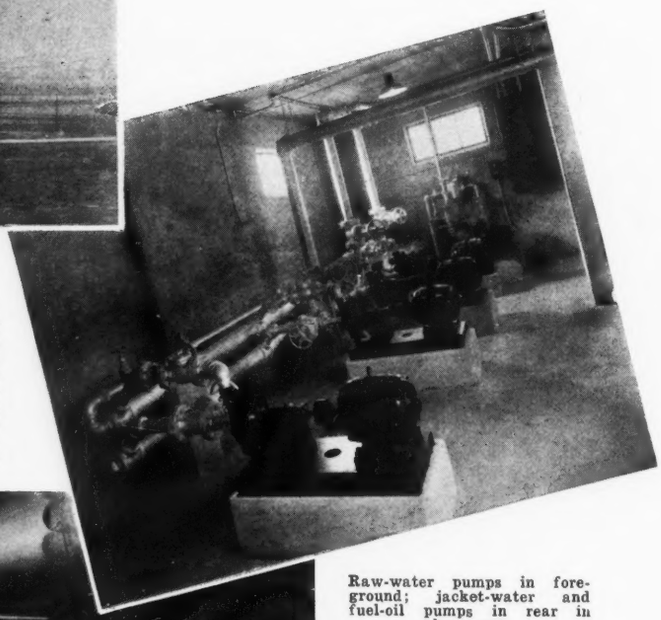
This reinforced-concrete, brick and steel structure houses two 300-kw. diesel sets

GLENN C. BOYER . . the designer of the Villisca plant is a Hawkeye himself, born in a suburb of Sioux City, Iowa, shortly after the turn of the century. His father, a railroad telegrapher, was like all railroaders—he couldn't stay put—so the Boyer family in 1913 was in Western Montana, with Father Boyer still working for the Milwaukee. Glenn finished grammar school at Alberton, Mont., high school at Missoula, college at Montana State. Summer vacations he worked for the railroad, the U. S. Bureau of Public Roads, the Forestry Service, a newspaper, or wherever he could find a job.

First paying job was city editor of the Missoula Sentinel. But Glenn had inherited his father's itch to travel. September, 1925, found him in the G. E. testing department, also taking advanced electrical work; November, 1926, in the valuation department of K. C. Power & Light; August, 1928, with American Eagle Aircraft doing structural design; April, 1929, starting an aircraft factory for Saul Aircraft at Carroll, Ia. Burns & McDonnell hired him in January, 1930.

But he's still traveling—over most of the U. S. and the Mexican west coast, inspecting gold diggings near Sutter's Mill, Calif., watching the elite play polo at Aitkin, S. C., hobnobbing with coal miners at Harlan, Ky., inspecting rock drilling at Norris Dam, and trying to make Mexican linemen understand his broken-down Spanish. His favorite plant is at Esperanza, Sonora, which in 1930 contained a 100-hp. Otto Dentz diesel belt-driving a 50-kva. Westinghouse generator and a 37.5-hp., 1-lung Fairbanks-Morse engine belted to a 25-kva. generator. Thirty services were connected in Esperanza and 32 in nearby Cocorit. A Chinaman was general manager, meter reader, bill collector, trouble shooter, ice-plant operator and iceman—in fact the entire personnel. The larger diesel operated continuously, so the Chinaman, after getting his ice-plant going, peddled his Ford-full of ice.

Glenn, in his spare time, likes to take pictures, and occasionally sits down at the piano to give the family a good laugh. Outside that, he's a Mason, member of the A.I.E.E. and Engineers Club of Kansas City.



Raw-water pumps in foreground; jacket-water and fuel-oil pumps in rear in basement

Water softener and air starting tanks at right, engine- and motor-driven air compressors at left, in basement of Villisca plant

for bids on both. When bids were opened, the difference in cost amounted to $1,200 in favor of the single-circuit system. We decided, however, that the double- or closed-cooling system was worth the additional investment, for savings in water-treating costs and added reliability in operation.

The Marley cooling tower, with sufficient capacity for one engine has 28 1-in. spray nozzles and a bypass for cold-weather operation. At the top of the raw-water basin is a cooling-coil assembly of two 4-in. cast-iron headers with 70 1-in., 18-ga., 10-ft. arsenical-copper connecting tubes in seven sections of 10 tubes each, thus permitting removal of a section for repairs with minimum shutdown. When peak load exceeds 300 kw., a third generating unit and a second cooling tower will be installed, so the foundation wall along the south side of the cooling-tower basin has been designed so that a second tower, south of the present one, will use the same foundation. Raw- and jacket-water piping between cooling tower and power plant will supply twice the existing cooling-tower capacity.

Connections between jacket-water cooling system, heating coils in the day fuel-oil tanks, and the two 15,000-gal. storage tanks, controlled by valves, permit circulation of sufficient warm water through the tanks to allow fuel oil to flow regardless of weather.

An emergency connection between jacket-water cooling system and the community water supply is provided through a spring-loaded pressure-regulated valve. An overflow connection on the surge tank direct to the sewer relieves the system of excess water. Make-up is softened by zeolite.

It was necessary to elevate the storage tanks, to provide positive head, over the 20-g.p.m. fuel-oil transfer pump in the basement. This pump loads oil into storage tanks from tank wagons, or fills the 300-gal. day tanks from storage when oil level becomes low or when day tanks are to be filled more rapidly than is possible by gravity. Fuel-oil meters and strainers are provided in day-tank connections, Fig. 1, to insure measured clean oil in the day tanks.

A Gould Hydroil centrifuge, a 2-compartment storage tank, and a 20-g.p.m. transfer pump make up the lubricating oil-treating system. Since a continuous lubricating-oil centrifuging system cannot be used with these engines, centrifuge and oil tank are connected for batch centrifuging and oil is

passed through the centrifuge as many times as necessary to clean it. The transfer pump fills the two oil-level reservoirs on the main floor, Fig. 2.

Both motor and gasoline-engine driven air compressors are provided, in addition to three air tanks for starting engines. Tank capacity is enough to start an engine 10 times without recharging.

Air for combustion is taken from the north side of the building through Midwest filters, a separate assembly for each engine. Each engine exhaust has a Maxim 14-in. silencer, resulting in a very quiet plant. Silencers are in a brick chamber at the rear.

The engine-room is heated by forced-air circulation around the silencers. A 2,400-c.f.m., forced-air fan, between engine room and silencer chamber at the engine-room floor line takes air from the engine-room floor, forces it around the silencers, and returns it through two adjustable louvres 15 ft. up on the wall to insure efficient distribution. Recent cold-weather operation of this waste-heat recovery system has demonstrated that sufficient heat is available for maintaining comfortable temperatures. A second set of adjustable louvres in the outside wall of the silencer chamber is used during the summer with the fan if necessary for cooling silencers.

Small electric units heat office and washroom. These rooms could have been heated by hot air circulated around the silencers, but cost of duct work and fans, with fan-operating costs, was more than the savings over electric heating.

In order to provide adequate switching facilities, working space around the switchboard was made ample so that maintenance men should be able to service any oil circuit breaker in a de-energized condition, while the board still provided service to the circuit normally fed by the breaker. This would normally mean a double- or transfer-bus switchboard, at considerable additional cost. The same effect was obtained at less cost with four sets of disconnect switches on the back wall of the switchboard cell, together with the conduit and cable for connections, Fig. 3. Sections in conduit are dotted.

All electrical circuits leave the plant underground and extend to terminal poles across the street, thereby eliminating possible interference with telephone circuits and improving appearance.

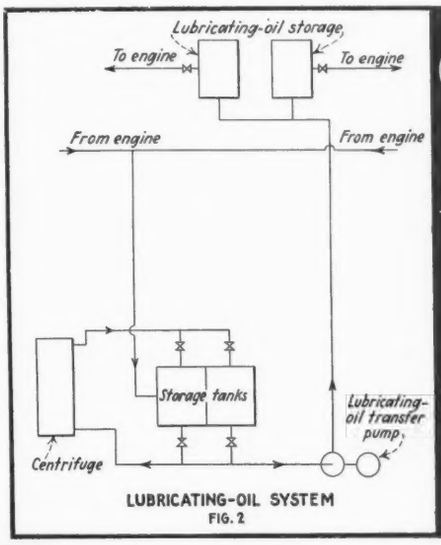
Prior to installation of the diesels, I tested one engine at the Fairbanks-Morse factory at Beloit, Wis. Guarantees had been called for at full, ¾, ½ and ¼ loads. In addition, I also watched a 2-hr. overload test, normally included in the factory routine test schedule. Guaranteed fuel-oil consumption per b.hp.-hr. was based on 19,000-B.t.u. high-heat-value oil. Here are results:

**GUARANTEED AND ACTUAL FUEL-OIL CONSUMPTION**

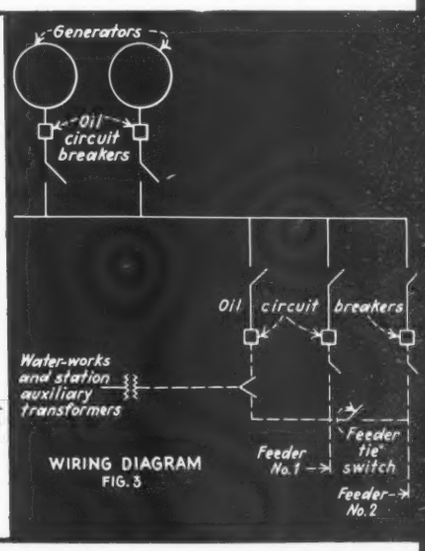
| | | | | | |
|---|---|---|---|---|---|
| **Guarantees** | | | | | |
| Brake Hp. Output of Engine. | | 450 | 337.5 | 225 | 112.5 |
| Per Cent Rated Load..... | | 100 | 75 | 50 | 25 |
| Fuel lb. per b.hp.-hr..... | | 0.40 | 0.41 | 0.44 | 0.58 |
| **Factory Test Runs** | | | | | |
| Brake Hp. Output.. | 553 | 450 | 333 | 229 | 115 |
| Per Cent Rated Load | 123 | 100 | 74 | 51 | 25.6 |
| Fuel lb. per b.h.p.-hr. | 0.401 | 0.388 | 0.392 | 0.421 | 0.560 |

In the table, test results have been reduced to a basis of 19,000-B.t.u.-per-lb. oil for comparison with guarantees. After the engine and generators were installed, field tests were conducted on both units. These tests were 2 to 3% under the guarantees, based on lb. of fuel oil per kw.-hr. generated.

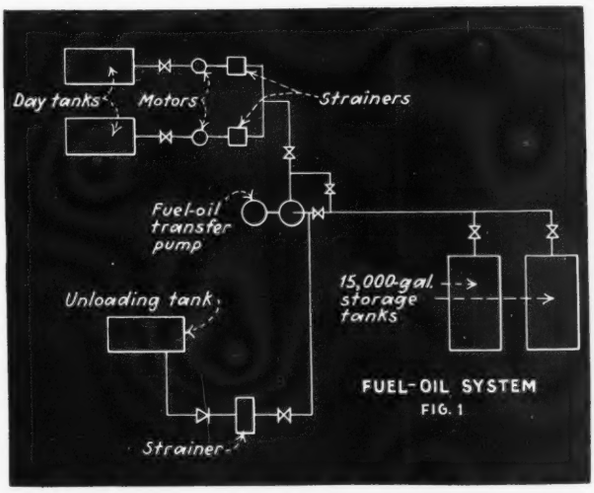
During field-test runs, the difference between cooling-water temperature in and out of jackets ranged from 5 to 9 deg. F. Engine exhaust temperatures at ½ load were about 290 deg. F., at ¾ load 340 deg. F., and at full load 400 deg. F.



LUBRICATING-OIL SYSTEM
FIG. 2



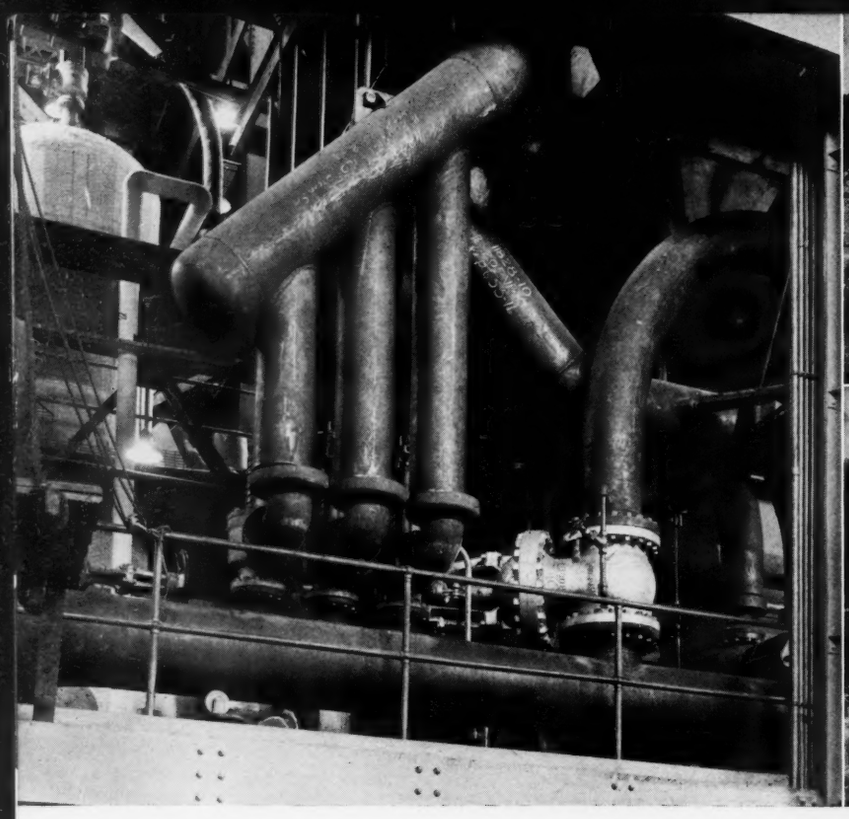
WIRING DIAGRAM
FIG. 3

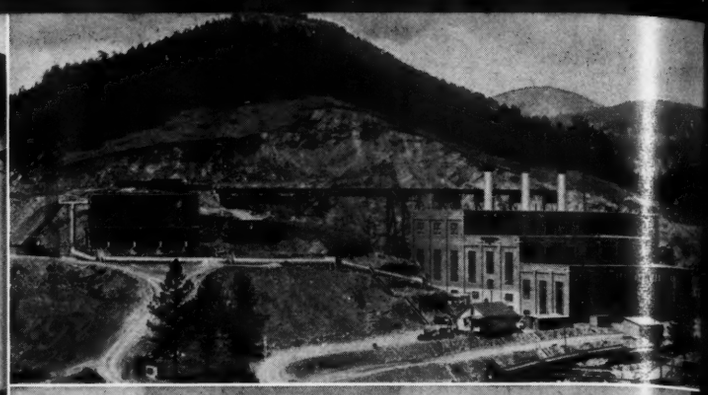


FUEL-OIL SYSTEM
FIG. 1

Contracts for construction were let June 24, 1936. Some work was started on the building about July 1, but it was not until Aug. 1 that construction got fully under way. Engines and generators arrived Sept. 5 and 7, and the plant started a 24-hr. schedule Nov. 23. Approximately 3½ mo. were required to complete the project, and the engines and generators with auxiliaries were erected and ready for operation in about 2½ mo. Contract price for plant and an electric distribution system was $136,200, of which approximately $90,000 represents plant. Thus plant cost was about $150 per kw., nominal considering the trend of costs and the small units.

All engineering work, including design and supervision of the power plant and distribution system, was done by Burns & McDonnell Engineering Co.





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THOROUGH TESTING
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DELIVERY ON SCHEDULE
WORK QUALIFIED FOR INSURANCE

Number 55

# Table for Calculating Necessary Capacitor Kva. To Correct Load to Desired Power Factor

DESIRED POWER-FACTOR IN PERCENTAGE

ORIGINAL POWER-FACTOR IN PERCENTAGE

| | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 1.537 | 1.564 | 1.591 | 1.616 | 1.644 | 1.668 | 1.694 | 1.773 | 1.747 | 1.777 | 1.805 | 1.832 | 1.861 | 1.895 | 1.924 | 1.959 | 1.998 | 2.037 | 2.085 | 2.146 | 2.288 |
| 41 | 1.474 | 1.501 | 1.527 | 1.553 | 1.581 | 1.605 | 1.631 | 1.659 | 1.684 | 1.713 | 1.742 | 1.769 | 1.798 | 1.831 | 1.860 | 1.896 | 1.935 | 1.973 | 2.021 | 2.082 | 2.225 |
| 42 | 1.413 | 1.440 | 1.467 | 1.492 | 1.520 | 1.544 | 1.571 | 1.599 | 1.623 | 1.653 | 1.681 | 1.709 | 1.738 | 1.771 | 1.800 | 1.836 | 1.874 | 1.913 | 1.961 | 2.022 | 2.164 |
| 43 | 1.356 | 1.383 | 1.409 | 1.435 | 1.463 | 1.487 | 1.513 | 1.541 | 1.566 | 1.596 | 1.624 | 1.651 | 1.680 | 1.713 | 1.742 | 1.778 | 1.816 | 1.855 | 1.903 | 1.964 | 2.107 |
| 44 | 1.290 | 1.317 | 1.344 | 1.369 | 1.397 | 1.421 | 1.447 | 1.476 | 1.500 | 1.529 | 1.558 | 1.585 | 1.614 | 1.647 | 1.677 | 1.712 | 1.751 | 1.790 | 1.837 | 1.899 | 2.041 |
| 45 | 1.230 | 1.264 | 1.290 | 1.316 | 1.341 | 1.360 | 1.394 | 1.422 | 1.447 | 1.476 | 1.501 | 1.532 | 1.561 | 1.592 | 1.626 | 1.659 | 1.695 | 1.737 | 1.784 | 1.846 | 1.988 |
| 46 | 1.179 | 1.205 | 1.231 | 1.267 | 1.282 | 1.309 | 1.335 | 1.363 | 1.388 | 1.417 | 1.446 | 1.473 | 1.502 | 1.533 | 1.567 | 1.600 | 1.636 | 1.677 | 1.725 | 1.786 | 1.929 |
| 47 | 1.130 | 1.157 | 1.183 | 1.209 | 1.234 | 1.260 | 1.287 | 1.315 | 1.340 | 1.369 | 1.397 | 1.425 | 1.454 | 1.485 | 1.519 | 1.552 | 1.588 | 1.629 | 1.677 | 1.758 | 1.881 |
| 48 | 1.076 | 1.102 | 1.128 | 1.154 | 1.179 | 1.206 | 1.232 | 1.260 | 1.285 | 1.314 | 1.343 | 1.370 | 1.400 | 1.430 | 1.464 | 1.497 | 1.534 | 1.575 | 1.623 | 1.684 | 1.826 |
| 49 | 1.030 | 1.058 | 1.084 | 1.110 | 1.135 | 1.160 | 1.188 | 1.216 | 1.241 | 1.270 | 1.297 | 1.326 | 1.355 | 1.386 | 1.420 | 1.453 | 1.489 | 1.530 | 1.578 | 1.639 | 1.782 |
| 50 | 982 | 1.008 | 1.034 | 1.060 | 1.086 | 1.112 | 1.139 | 1.165 | 1.192 | 1.220 | 1.248 | 1.276 | 1.303 | 1.337 | 1.369 | 1.403 | 1.441 | 1.481 | 1.529 | 1.590 | 1.732 |
| 51 | .936 | .962 | .988 | 1.014 | 1.040 | 1.066 | 1.093 | 1.119 | 1.146 | 1.174 | 1.202 | 1.230 | 1.257 | 1.291 | 1.323 | 1.357 | 1.395 | 1.435 | 1.483 | 1.544 | 1.686 |
| 52 | .894 | .920 | .946 | .972 | .998 | 1.024 | 1.051 | 1.077 | 1.104 | 1.132 | 1.160 | 1.188 | 1.215 | 1.249 | 1.281 | 1.315 | 1.353 | 1.393 | 1.441 | 1.502 | 1.644 |
| 53 | .850 | .876 | .902 | .928 | .954 | .980 | 1.007 | 1.033 | 1.060 | 1.088 | 1.116 | 1.144 | 1.171 | 1.205 | 1.237 | 1,271 | 1.309 | 1.349 | 1.397 | 1 458 | 1.600 |
| 54 | .809 | .835 | .861 | 887 | .913 | .939 | .966 | .992 | 1.019 | 1.047 | 1.075 | 1.103 | 1.130 | 1.164 | 1.196 | 1.230 | 1.268 | 1.308 | 1 356 | 1.417 | 1 559 |
| 55 | .769 | .795 | .821 | .847 | .873 | .899 | .926 | .952 | .979 | 1.007 | 1.035 | 1.063 | 1.090 | 1.124 | 1.156 | 1.190 | 1.228 | 1.268 | 1.316 | 1.377 | 1.519 |
| 56 | .730 | .756 | .782 | .808 | .834 | .860 | .887 | .913 | 940 | .968 | .996 | 1.024 | 1.051 | 1.085 | 1.117 | 1.151 | 1.189 | 1.229 | 1.277 | 1.338 | 1.480 |
| 57 | .692 | .718 | .744 | 770 | .796 | .822 | .849 | .875 | .902 | .930 | .958 | .986 | 1.013 | 1.047 | 1.079 | 1.113 | 1.151 | 1.191 | 1.239 | 1.300 | 1.442 |
| 58 | .655 | .681 | .707 | .733 | .759 | .785 | .812 | .838 | .865 | .893 | .921 | .949 | .976 | 1.010 | 1.042 | 1.076 | 1.114 | 1.154 | 1.202 | 1.263 | 1.405 |
| 59 | .618 | .644 | .670 | .696 | .722 | .748 | .775 | .801 | .828 | .856 | .884 | .912 | .939 | .973 | 1.005 | 1.039 | 1.077 | 1.117 | 1.165 | 1.226 | 1 368 |
| 60 | .584 | .610 | .636 | .662 | .688 | .714 | .741 | .767 | 794 | .822 | .849 | .878 | .905 | .939 | .971 | 1.005 | 1.043 | 1.083 | 1.131 | 1.192 | 1.334 |
| 61 | .549 | .575 | .601 | .627 | .653 | .679 | .706 | .732 | .759 | .787 | .815 | .843 | .870 | .904 | .936 | .970 | 1.008 | 1.048 | 1.096 | 1.157 | 1.299 |
| 62 | .515 | .541 | .567 | .593 | .619 | .645 | 672 | 698 | 725 | .753 | 781 | .809 | .836 | .870 | .902 | .936 | .974 | 1.014 | 1.062 | 1.123 | 1.265 |
| 63 | .483 | .509 | .535 | .561 | .587 | .613 | .640 | 666 | .693 | .721 | .749 | .777 | .804 | .838 | .870 | .504 | .942 | .982 | 1.030 | 1.091 | 1.233 |
| 64 | .450 | .476 | .502 | .528 | .554 | .580 | .607 | .633 | .660 | .688 | .716 | .744 | .771 | .805 | .837 | .871 | .909 | .949 | .997 | 1.058 | 1.200 |
| 65 | .419 | .445 | .471 | .497 | .523 | .549 | .576 | 602 | .629 | .657 | .685 | .713 | .740 | .774 | .806 | .840 | .878 | .918 | .966 | 1.027 | 1.169 |
| 66 | .388 | .414 | .440 | .466 | .492 | 518 | .545 | .571 | .598 | .626 | .554 | .682 | .709 | .743 | .775 | .809 | .847 | .887 | .935 | .996 | 1.138 |
| 67 | .358 | .384 | .410 | .436 | .462 | .488 | .515 | .541 | .568 | .596 | .624 | .652 | .679 | .713 | .745 | .779 | .817 | .857 | .905 | .966 | 1.108 |
| 68 | .329 | .355 | .381 | .407 | .433 | .459 | .486 | .512 | .539 | .567 | .595 | .623 | .650 | .684 | .716 | .750 | .788 | .828 | .876 | .937 | 1.079 |
| 69 | .209 | .325 | .351 | .377 | .403 | .429 | .456 | .482 | .509 | .537 | .565 | .593 | .620 | .654 | .686 | .720 | .758 | .798 | .840 | .907 | 1.049 |
| 70 | .270 | .296 | .322 | .348 | .374 | .400 | .427 | .453 | .480 | .508 | .536 | .564 | .591 | .625 | .657 | 691 | .729 | .769 | .811 | .878 | 1.020 |
| 71 | .242 | .268 | .294 | .320 | .346 | .372 | .399 | 425 | .452 | .480 | .508 | .536 | .563 | .597 | .629 | .663 | .701 | .741 | .783 | .850 | .992 |
| 72 | .213 | .239 | .265 | 291 | .317 | 343 | .370 | .396 | .423 | .451 | .479 | .507 | .534 | .568 | .600 | 634 | .672 | .712 | .754 | .821 | .963 |
| 73 | 186 | .212 | .238 | .264 | .290 | .316 | .343 | 369 | .396 | .424 | .452 | .480 | .507 | .541 | .573 | .607 | .645 | .685 | .727 | .794 | .936 |
| 74 | 159 | .185 | .211 | .237 | .263 | .289 | .316 | .342 | 369 | .397 | .425 | .453 | .480 | .514 | 546 | .580 | .618 | .658 | .700 | .767 | .909 |
| 75 | 132 | 158 | 184 | .210 | .236 | .262 | .289 | .315 | .342 | .370 | 398 | .426 | .453 | .487 | .519 | .553 | .591 | .631 | .673 | .740 | .882 |
| 76 | 105 | .131 | 157 | .183 | .209 | .235 | .262 | .288 | .315 | .343 | .371 | .399 | .426 | .460 | .492 | .526 | .564 | .604 | .652 | .713 | .855 |
| 77 | .079 | .105 | 131 | 157 | .183 | .209 | 236 | .262 | .289 | .317 | .345 | .373 | .400 | .434 | .466 | .500 | .538 | .578 | .620 | .687 | .829 |
| 78 | .053 | .079 | .105 | 131 | .157 | .183 | .210 | .236 | .263 | .291 | .319 | .347 | .374 | .408 | 440 | .474 | .512 | .552 | .594 | .661 | .803 |
| 79 | .026 | .052 | .078 | .104 | .130 | .156 | .183 | .209 | .236 | .264 | .292 | .320 | .347 | .381 | .413 | .447 | .485 | .525 | .567 | .634 | .776 |
| 80 | .000 | .026 | .052 | .078 | .104 | .130 | .157 | .183 | .210 | .238 | .266 | .294 | .321 | .355 | .387 | .421 | .459 | .499 | .541 | .608 | .750 |
| 81 | — | .000 | .026 | .052 | .078 | .104 | .131 | .157 | .184 | .212 | .240 | .268 | .295 | .329 | .361 | .395 | .433 | .473 | .515 | .582 | .724 |
| 82 | — | — | .000 | 026 | .052 | .078 | .105 | .131 | .158 | .186 | .214 | .242 | .269 | .303 | .335 | .369 | .407 | .447 | .489 | .556 | .698 |
| 83 | — | — | — | .000 | .026 | .052 | .079 | .105 | .132 | .160 | .188 | .216 | .243 | .277 | .309 | .343 | .381 | .421 | .463 | .530 | .672 |
| 84 | — | — | — | — | .000 | .026 | .053 | .079 | .106 | .134 | .162 | .190 | .217 | .251 | .283 | .317 | .355 | .395 | .437 | .504 | .645 |
| 85 | — | — | — | — | — | .000 | .027 | .053 | .080 | .108 | .136 | .164 | .191 | .225 | .257 | .291 | .329 | .369 | .417 | .478 | .620 |

This reference table is for calculating necessary capacitor kva. to correct load to desired power factor. Among other functions, it computes the reactive kva. required to raise the power factor to any desired percentage. See example.

*Example*—Total kilowatt output from plant from wattmeter reading is 100 kw. at a power factor of 60%. The leading reactive kva. necessary to raise power factor to 90% is found by multiplying the 100 kw. by the factor found in the table, which in this case is 0.849. Thus, 100 kw. × 0.849 = 84.9 kva. Use 85 kva.



Courtesy Cornell-Dubilier Corporation

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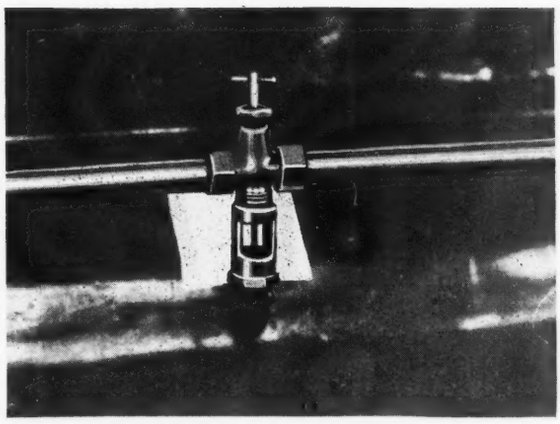
# PRACTICAL AIDS TO OPERATION



## Shedding Light on Sight Feeds

SMALL STREAMS of lubricating oil flowing through sight feeds could not be readily distinguished from the dark background of gas engines whose main bearings they are intended to oil. This difficulty was corrected by painting a 4-in. square with aluminum paint on the engine base directly behind each sight-feed glass. Now the oil stream shows up clearly against this bright spot, and any change in flow is noticed instantly by the oiler from any position on that side of the power unit. Incidentally, with the bright spot of aluminum behind each sight feed to show up any stain or discoloration, the men in charge make extra effort to keep sight glasses clean.

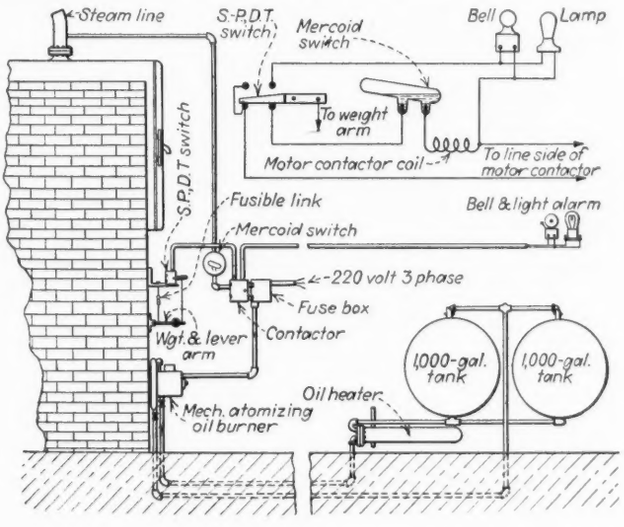
*Longview, Texas* — ELTON STERRETT

## Fusible Link for Fire Protection

A CONDITION was discovered in a boiler plant recently which might have resulted in a serious fire and explosion. Boilers, equipped with steam-pressure controlled oil burners, were being operated at low temperature for heating. Two 1,000-gal. oil-storage tanks had been installed in the boiler room opposite the boilers. As both feedwater and oil-burner control were automatic, no regular attendant was on duty. Infrequent visits were made to the boiler room during the day to ascertain how the plant was operating.

Possibilities of serious trouble existed with this installation, for if water from tank condensation or dirt happened to pass through the burner, the fire might be extinguished, as would also occur if the automatic-ignition equipment failed. Oil would then flood the furnace and floor, and if the furnace brickwork was still hot, oil might ignite and flare back to the oil-storage tanks.

Installing a single-pole, double-throw switch operated by a fusible link and connected in series with the oil-pump motor contactor-coil circuit, as in the figure, was used to stop the motor in case of fire in one plant. An alarm system was also connected to the fusible-link switch and the light and bell located in a part of the plant where attendants are always present.




*Cleveland, Ohio* — A. G. WIGGINS

## How to Treat Pits in Steam Boilers

THERE is a difference of opinion about proper treatment of pit holes in boilers. Some engineers advise a hands-off policy; others recommend cleaning and filling them in; still others advise cleaning and applying a thin corrosion-resistant coating.

Some engineers maintain that, granted a fairly uniform metal surface, changing conditions tend to reverse the polarity of the pitted areas and, therefore, to distribute corrosion more evenly. The converse of this statement appears to be true, however, for pitting is an uneven and very localized form of corrosion. Once a pit has started, the break in the metal surface is conducive to even more rapid penetration. Thus, if corrosive action is present, neglected pit holes are susceptible places for concentrated attack.

Filler is usually composed of lime and graphite, litharge and glycerin, silicate of soda, or puttys containing some of these substances. Pits are filled flush with the boiler plate. In a few months, after scale has formed, it is almost impossible to distinguish old pit locations. This

may be a desirable way to handle the problem, but suppose that 5 yr. have passed since pits were filled and new pits have formed between the old ones. A boiler inspector examines the boiler, and is not aware of hidden pits; he can only see the new and apparently scattered pitting. The figure illustrates the existing condition. Alone, the scattered new pits would not seriously affect boiler strength and safety, but in conjunction with the old pits, a dangerous condition exists.

One of the most flagrant violations of all recognized boiler codes occurred recently in a plant having longitudinal-drum, watertube boilers. Internal surfaces of one boiler drum had been pitted moderately for many years. Some years previously, surfaces were wire-brushed clean and coated with an anti-corrosive preparation.

This checked all further active corrosion, and to play safe, the coating was renewed every two years. A few months ago, new owners, on the advice of an incompetent person, had the protective coating scraped from the drum surfaces. A welder was hired to chisel a groove connecting the closest of the pits by a groove $\frac{1}{8}$ in. deep and 8-in. long and fill the groove flush by electric welding. As the original thickness of the boiler plate was $\frac{3}{8}$ in., the groove penetrated 33% of the metal thickness. This entirely unnecessary and unsatisfactory repair causes a concentration of stresses in the plate that may, in time, cause serious trouble. Weld strength cannot be considered, and this procedure definitely weakened the plate, in which none of the old pits were more than 3/32 in. deep or closer than 1 in.

The third method of handling pitting has proved the best. The roughened, irregular surfaces should be wire-brushed clean. A corrosion-resistant paint, Portland-cement wash, or a similar coating should be applied to the surfaces of the pits, but not thick enough to fill the hole. Areas susceptible to corrosion are thus protected from direct contact with the corrosive solution. This method is recommended for all cases where practical methods for water treatment have been tried and active corrosion still prevails.

*Chicago, Ill.* R. O. BILLINGS

## Celluloid Disks Prevent Glass From Breaking

IF A CELLULOID disk, cut the same size as the glass face of meters and gages, is placed on the outside of the glass, it will frequently prevent the glass from being broken or cracked by accidental blows. Simply fit the celluloid disk over the glass under the ring that holds the glass in place. Being softer and more flexible than the glass face, the celluloid will absorb light blows that would crack the glass.

*Omaha, Neb.* JOSEPH J. LIPICHOK, JR.

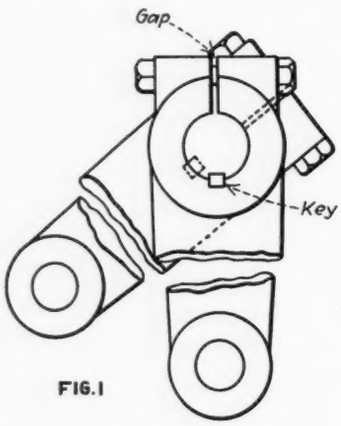


FIG. 1

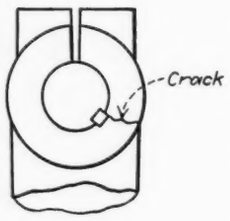


FIG. 2

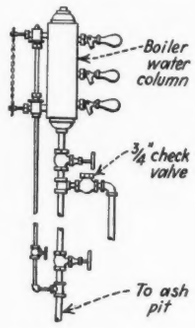
## Keyways in Valve Gear Rocker Arms

HEAVY STRESSES are often produced in a steam-engine valve gear regardless of attempts to eliminate friction and to balance valves. How the keyways are cut has a lot to do with possibilities of rocker-arm failure. Fig. 1 shows the proper method of designing and machining a double rocker-arm assembly. Two keyways are cut approximately 50 deg. apart, so that the keyways in the arms come exactly opposite the gaps in their ends. Before the holes in the arms are bored and finished, the gap is forced open a few thousandths of an inch and held by a block. Then when the arms are assembled on the shaft, they will assume their natural position and hug shaft and keys with a good fit.

If only one keyway is cut in the rocker-arm shaft, then the keyway in one of the arms will have to be cut to one side of the center line passing through the gap, as in Fig. 2. This I have found causes rocker-arms to crack.

*New York, N. Y.* C. W. PETERS

## Vacuum Breaker on Boiler Prevents Manhole Leaks




LEAKY manhole covers on our boilers led us to believe that a vacuum was forming when boilers were allowed to cool off over night. To correct this I installed the vacuum breaker, as in the figure. A stop valve was placed close to the bottom of the water column in the blowdown line. Just below this valve a tee was placed for connecting in a check valve with a hot-water disk. The check valve is so installed that boiler pressure holds it closed and air pressure opens it when a vacuum forms in the boiler.

The amount of vacuum in the boiler before the check valve opens depends upon the distance this valve is below the water line. At present about 1 in. vacuum develops before the check valve admits air. At the first opportunity I intend to connect the check valve into the top of the water column and practically eliminate vacuum in the boiler. Since installing this device, no trouble has been experienced with leaky manhole joints.

*Englewood, N. J.* R. BOETTINGER

## Proper Instruction Reduces Safety-Valve Leakage

MAINTENANCE required by modern steam power plants is largely dependent upon refinement of operating procedure. Present-day design, materials, and shop practice have all contributed to the development of trouble-free steam generators, prime movers, auxiliaries, and accessories. This built-in ruggedness is reflected in greatly reduced maintenance costs even though the equipment may be subjected to severe service and careless handling. Maintenance costs may be further lowered by analyzing each failure as it occurs to determine the cause. When the source is isolated, changes in operating practice can usually be made which will eliminate or minimize similar troubles in the future.

Operating records of a large 400-lb. pulverized-fuel fired industrial power plant illustrate this point. Boiler-repair costs were appreciably increased by the necessity of machining and grinding seating surfaces of one or more leaking safety valves whenever a unit was removed

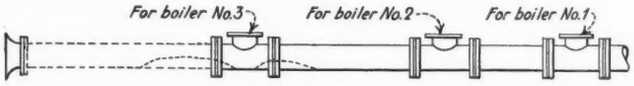
from service for inspection and maintenance. Over-all operating costs were also increased by losses from almost continuous steam leakage at the atmospheric end of safety-valve escape pipes.

A study of this problem revealed that, due to sudden load changes or operator's negligence, boiler pressure would often increase to a point where safety valves would commence to simmer without actually popping. Warned by the noise, operators would lower the pressure until normal conditions were restored. Thus simmering disturbed seat and disk alignment, allowing leakage which eventually caused cutting of seating surfaces.

Safety-valve maintenance costs and leakage losses were considerably reduced by posting instructions concerning simmering.

"Whenever boiler pressure rises to a point causing safety valves to simmer, the operator, after pressure has been restored to normal, will lift valves by hand, so that positive opening and closing of the valve will be assured. At intervals of two hours after performing this operation, he will check the safety valves for signs of leakage and lift the valve again, if necessary, until no preventable leakage exists."

*New York, N. Y.* S. H. COLEMAN




## Changing Ash Remover Eliminates Trouble

WE WERE having considerable trouble in removing ashes from our No. 3 boiler with a steam-jet ash conveyor, yet the system on boilers No. 1 and 2 operated satisfactorily. It was found that ashes, washed down from No. 3 ashpit when we blew down the water column, built up inside of the conveyor pipe around the intake tee of No. 3 boiler, as indicated by curved dotted lines in the figure. This also occurred on boilers No. 1 and 2, but the pipe was cleaned out by clinkers and ashes discharged from No. 2 and 3 boilers.

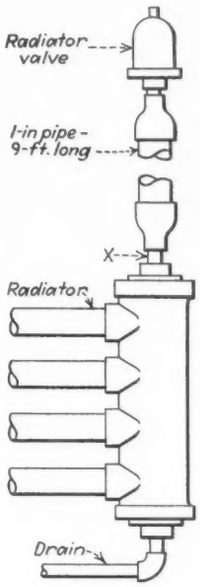
When the conveying system was constructed, an extra length of pipe, shown in dotted lines in the figure, was installed to remove fly ash from the stack base, but was never used. We removed this section of pipe, and placed the air intake close to the tee for No. 3 boiler. This change was made over a year ago and we have had no trouble with the ash-removal system since.

*Cleveland, O.* THOMAS C. BROCK

## Temporary Cure for Spitting Radiator Air Valve

ONE OF our wall radiators was giving trouble, probably because of faulty installation. In the morning, when high-pressure steam was turned into the heating system, the radiator air valve, located at *X* in the sketch, would pass a considerable amount of water until steam reached the valve and closed it.

For various reasons, it was not advisable to correct the faulty installation at that time, and a temporary remedy was sought. We removed the valve and inserted a 9-ft. (maximum length ceiling height would permit) section of 1-in. pipe in the end header of the radiator, and placed the valve at the upper end of the pipe. This cured valve-spitting difficulties. My explanation is that the pipe serves as a standpipe for cold water, allowing confined air to pass through the radiator air valve without forcing water out ahead.

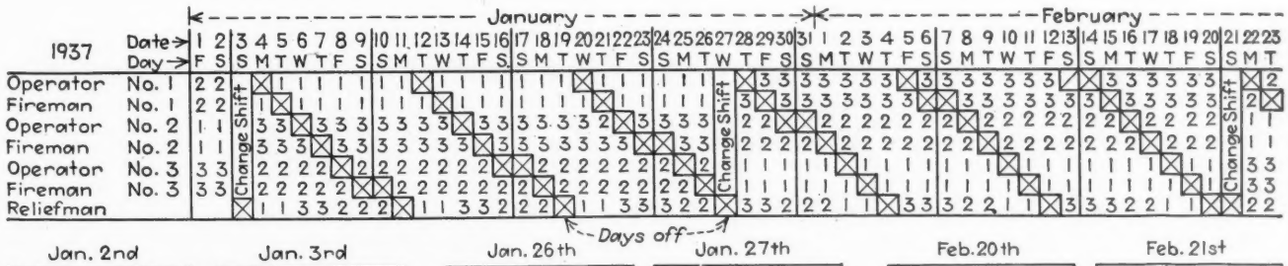



*Worcester, Mass.* DAVID FLIEGELMAN

## Plant Operators' Shift Schedule

MANY different shift schedules have been worked out for power-plant operators. The one shown here was devised to permit operators a change in shift every 7 weeks, with an 8-hr. working day. The schedule may be started on any day, but in this case was arbitrarily begun on Sunday, Jan. 3. Each man gets a day off every eight, and over a 7-week period has a Saturday and Sunday off together. This schedule, then, works out to give each man the equivalent of one day off per week on a different day each week, as indicated by crossed squares. The relief man has the advantage of working the regular shift schedule.

*Scottsbluff, Neb.* C. A. DEURSEN




| Jan. 2nd | | Jan. 3rd | | Jan. 26th | | Jan. 27th | | Feb. 20th | | Feb. 21st | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1st Shift-Op'r | No. 2 | 1st Shift-Op'r | No. 1 | 1st Shift-Op'r | No. 1 | 1st Shift-Op'r | No. 3 | 1st Shift-Op'r | No. 3 | 1st Shift-Op'r | No. 2 |
| 2nd " " | No. 1 | 2nd " " | No. 3 | 2nd " " | No. 3 | 2nd " " | No. 2 | 2nd " " | No. 2 | 2nd " " | No. 1 |
| 3rd " " | No. 3 | 3rd " " | No. 2 | 3rd " " | No. 2 | 3rd " " | No. 1 | 3rd " " | No. 1 | 3rd " " | No. 3 |
| 1st " Fireman | No. 2 | 1st " Fireman | No. 1 | 1st " Fireman | No. 1 | 1st " Fireman | No. 3 | 1st " Fireman | No. 3 | 1st " Fireman | No. 2 |
| 2nd " " | No. 1 | 2nd " " | No. 3 | 2nd " " | No. 3 | 2nd " " | No. 2 | 2nd " " | No. 2 | 2nd " " | No. 1 |
| 3rd " " | No. 3 | 3rd " " | No. 2 | 3rd " Reliefman | | 3rd " " | No. 1 | 3rd " " | No. 1 | 3rd " " | No. 3 |
| Shift Change | | | | Shift Change | | | | Shift Change | | | |

# CURRENT COMMENT

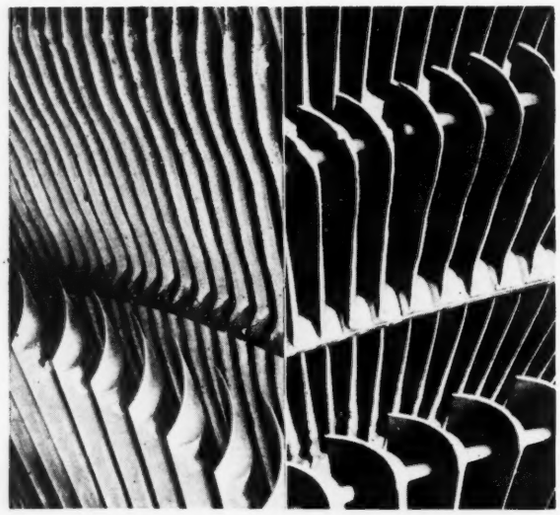


Fig. 1—(Left) 25th and 26th rows of blading in a 25,000-kw. turbine. Fig. 2—Same blade rows as Fig. 1, but showing blade profile

## When to Reblade Turbines

THE article in *Power*, July, 1936, by W. H. Lloyd, points to the fact that certain blade materials are more corrosion resistant than materials used in earlier blading. Erosion of blades, on the other hand, is to a large extent preventable by proper design, velocities of steam and condition or character of the steam.

Changes in blade shape due to corrosion or erosion adversely affect economy of the turbine; blade replacements are justified under these conditions for economic reasons as well as safety.

Where blade fractures have occurred due to resultant stress in the blade, replacement must be made, but such replacement should be made with blades made from materials and of a design that will eliminate, or at least reduce to a minimum, the primary cause of the blade fracture.

Fig. 1 shows the 25th and 26th rows of blading in a 25,000-kw. turbine spindle; this unit has been in active service for 64,749 running hours. This time is equal to 7 yr. and 5 mo. continuous operation. The unit produced 902,136,000 kw.-hr. Note the condition of the 25th row as compared with the blades in the 26th row. The 25th row is of stainless steel and has been in service for 23,465 hr.; the 26th row is of carbon steel and has been in use for 64,749 hr. Note the irregular erosion of the inlet edges of these blades. This comparison speaks well for the newer blade material. From Fig. 2 note that the entire profile of the blades in the 26th row has been completely eroded away, and the practically perfect blade tip profile of the 25th row after 23,465 hr. of use.

Fig. 3 shows new blades of the type used for the 26th, 27th, 28th and 29th rows, all manufactured of stainless steel, and the old blades which they replace. Note the change in design of the 26th and 27th rows. The condition of the 26th row from erosion near the center of the blade shows where a serious failure would have occurred by fatigue crack due to the reduced section of the blade. Erosion of the 27th row, with resultant reduction of blade width, is shown as well as reduction of blade width in the 28th and 29th rows.

This turbine is operated with steam pressure of 390 lb. per sq.in. gage and at a temperature rating of 700 deg.

*Grand Tower, Ill.* J. B. COTTER
*Supt., Power Stations, Central Illinois Public Service Co.*

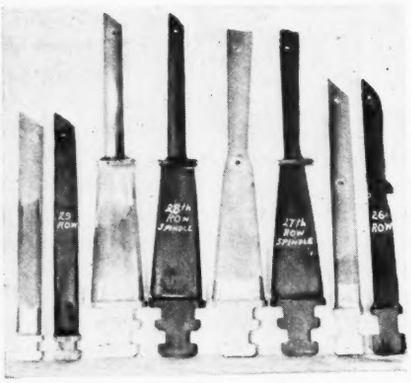


Fig. 3—The light-colored blades are new stainless steel blades replacing the darker ones

## A Quick Repair For Foundation Bolts

IN A recent *Power* I read with interest an article on several methods of repairing broken engine-foundation bolts. It recalls to my mind a method which I have employed and which has proven satisfactory in every case where it became necessary to repair quickly a broken foundation bolt. In each case the foundation bolt had broken off flush with or a short distance below the top of the concrete foundation.

Sufficient concrete was first chipped away to expose the broken end of the stub in the foundation and to make the broken end easily accessible. In the meantime a new threaded bolt-end of the same dimensions as the broken end was prepared. An oxy-acetylene torch was then used to weld the prepared bolt-end to the stub.

The opening around the repaired bolt was filled with a fresh cement mixture, the usual procedure being followed to insure a good bond to the old concrete.

This method of repair is simple and causes very little disturbance of the old bolt, permitting the repaired bolt to carry its full load immediately. Where the location of the broken bolt permits, repairs may be made without disturbing the engine or other fixtures.

*Sioux City, Ia.* P. A. STARCK

## Why Compressed-Air Explosions?

I AGREE with Mr. C. O. Sandstrom's theory outlined in "Why Compressed-Air Explosions?" *Power*, September, 1936, but in practice there are conditions under which leaky discharge valves may contribute to an explosion. Receiver explosions may be caused by a combination of circumstances, such as too much oil of an inferior quality passing to the receiver and too high a discharge temperature, which frequently is the case with single-stage compression. High temperature evaporates volatile parts of the oil, which may unite with oxygen to form a combustible mixture in some part of the receiver system. Then, in single-stage compression, a temperature high enough to ignite this mixture may be attained, with disastrous results.

Single-stage air compression at the common operating pressure of 100 lb. per sq. in. may generate discharge temperatures as high as 450 to 500 deg. F. Average flash and fire points of accepted brands of oils, often used in compressor crankcases, is 400 to 450 deg. F. Here in itself, we are on the borderline of danger if a volatile mixture occurs near the compressor discharge. With operation so near the critical point, any slight additional heat may be just enough to ignite the mixture.

For this reason, most compressor builders, recommend 2-stage compression for all pressures over 80 lb. per sq.in., except in smaller sizes where a large amount of heat is dissipated through radiation.

It is conceded that air admitted through a leaky discharge valve during the suction stroke gives up energy, but we also know that in practice it does this inefficiently. In other words, the same energy is not returned that was expended on the compression stroke. Furthermore, all air that leaks into the cylinder during compression increases the mean effective pressure, hence the final temperature. Addition of this temperature to the already dangerously high temperature generated with single-stage compression may be enough to start an explosion.

*Corning, N. Y.* J. W. JONES.

## To Make Charts

IN YOUR *December issue of* Power, *in the section "Power Serves Process," there appear several very interesting charts combining various properties of substances and showing one final result. Will you please publish an explanation of the mathematical and thermodynamic principles involved?*—M.A.A.

The writer of the foregoing question omitted his name and address, signing with initials only. While questions in this section are published with no identification other than the initials, complete name and address should be given in letters, so that we may reply privately, if the character of the question does not justify its publication with answer.

Most of the charts in the special section were prepared by *Power's* editorial staff, who are therefore intimately familiar with the technique involved. However, to explain how all of them were plotted would probably take 20 pages, and is therefore entirely impracticable.

The editors would like to learn whether an appreciable number of readers would be interested in two or three short articles showing how the simpler forms of computing charts are laid out, with particular emphasis on colinear diagrams (several scales intersected by straight lines).—EDITOR.

### Galvanism, Not Electrolysis

JANUARY *Power* is at hand. On page 19, is reported an abstract from "Research Illustrated" on corrosion. Be advised that the phenomenon described is galvanism, not electrolysis, which latter requires an externally-generated current for its production, while the former requires a wet and a dry contact between two dissimilar metals. The ordinary result is deposit of one metal on the other, as copper on zinc, but the addition of, say vinegar, changes the copper deposit to a salt deposit and the unbalance chemically in the galvanic fluid is counterbalanced by removal of zinc (the negative electrode) and its combination in the fluid. Movement of an electrode causes curvilinear flow of ions which may become zero with increase of electrode interval due to internal fluid resistance.

*Newberry, Mich.* R. R. RYAN

# THE ENGINEER'S BOOKSHELF

## Electron Tubes

ELECTRON TUBES IN INDUSTRY (2ND EDITION)—*By Keith Henney, Editor* Electronics. *Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 539 pages, 6x9 in. Illustrated. Price $5.*

Two years ago, in his first edition, Mr. Henney stated that non-communication uses of electron tubes were growing impressively. This growth has continued at an accelerating pace as industry has discovered possibilities of the tube for process control. This volume presents new circuits and developments, and the text is entirely reset.

Applications of amplifiers, oscillators, photo-tubes, rectifiers, thyratrons, grid-glow tubes and cathode-ray tubes are included. Discussions are in simple language, and the author "names names"—he tells where these new units can be obtained, what they will do, and what they won't do. He also gives further references, if you want to pursue the subject in detail. All-in-all, it is an excellent working manual on an increasingly useful tool.

## D.C. Machines

CONNECTING AND TESTING DIRECT-CURRENT MACHINES (1937)—*By F. A. Annett, Associate Editor,* Power, *and A. C. Roe, Insulation Engineer Westinghouse Electric & Mfg. Co. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y., 302 pages, 6x9 in. 224 illustrations, 12 tables. Price $3.*

This book, a second edition, is a revised and up-to-date practical presentation of problems arising in reconnecting d.c. machines for changes in speed and voltage. One of six new chapters includes work done by the National Manufacturers Assn. in classifying armature and field coils according to insulation. Other chapters describe improvements in insulation and construction methods that have made it possible to increase ratings of old machines by installing new windings, armature-coil construction and how to bring out leads, testing lap-wound armatures with equalizer connections, a new method of applying high-frequency high voltage to coils or groups of coils to test their insulation, and how to make insulation-resistance measurements and use them intelligently.

The new edition, like the first, is in two sections. The first deals with reconnecting d.c.-machine winding for changed operating conditions, and the second, with locating and remedying faults in this type of machie.

## Social Pattern of Power

LIVING TOGETHER IN A POWER AGE (1936)—*By Samuel S. Wyer. Published by Association Press, New York, N. Y. 231 pages, 6x9¼ in. Price $2.50.*

"Living Together", as the name implies, is primarily social in its purpose and outlook, but bases its conclusions on a foundation of power statistics. The excuse, of course, is that power is the most fundamental technical factor in modern life. The social conclusions carry the reader into a field of opinion lying outside the scope of this magazine. Some readers will agree with the author's views, some will not, and many will agree in part. All that can properly be said here is that Mr. Wyer, who is a mechanical engineer, presents his subject clearly and intelligently.

## Formulary

HENLEY'S 20TH CENTURY FORMULA BOOK (1937)—*By Prof. T. O'Conor Sloane. Published by Norman W. Henley Publishing Co., 2 W. 45th St., New York, N. Y. 900 pages, 5½x8½ in. Price $4.*

A revised and enlarged edition of a text in use for many years, this is a complete reference on formulas, processes, and trade practices. It includes everything from agricultural insecticides to wines, but many sections concern subjects of particular interest to engineers: alloys, oils, lubricants, refrigerants, paints, steels and soldering.

## BRIEF REVIEWS

LESSONS IN ARC WELDING (1936). *Published and compiled by Lincoln Electric Co., Cleveland, Ohio. Mimeographed. Price 50 cents*—44 practical lessons in welding with diagrams showing exactly how to make different welds.

GLOSSARY OF IMPORTANT POWER AND RATE TERMS, ABBREVIATIONS AND UNITS OF MEASUREMENTS. *Published by Federal Power Commission, Washington, D. C., and available from Superintendent of Documents, Washington, at 5 cents per copy.*—Provides uniform terminology for F.P.C. documents and correspondence. Defines 184 terms, 196 abbreviations and 151 units of measurement, as well as giving a list of conversion factors.

PRESSURE-ENTROPY DIAGRAM FOR STEAM AND INTERNAL-ENERGY PRESSURE CHART FOR STEAM (1936). *By Cho-Lan Yin. Published by National Tsing Hua University, Peiping, China. Price not stated*—Although independent publications, these two are twins. Each consists of a 5½x7½-in. envelope containing a 20x30-in. chart and a small booklet of explanations and instructions. All material is in English (both language and units) and charts are based on the Standard U. S. (Keenan) tables. Engineers who make frequent computations will find these charts helpful.

REPORT OF THE RESEARCH AND EXTENSION ACTIVITIES, PURDUE UNIVERSITY, FOR THE SESSIONS OF 1935-36 & ELECTRICAL CONDUCTIVITY OF FIRE STREAMS. (1936.) *Free from Engineering Experiment Station, Purdue University, Lafayette, Ind. Ask for Research series No. 55 and 53*—Two bulletins: the first a 52-page report including some statistics on power research, the second a study of electrical conductivity and resistance of fire streams.

STANDARDS ON COAL AND COKE (1936). *Published by A.S.T.M., 260 S. Broad St., Philadelphia, Pa. Price $1.25*—144-page booklet. Includes sampling and testing methods, chemical analysis, specifications and classifications, and definitions of terms.

STANDARD TEST CODE FOR DISC AND PROPELLER FANS, CENTRIFUGAL FANS AND BLOWERS. *Prepared by joint committee of National Association of Fan Manufacturers and the American Society of Heating and Ventilating Engineers and published by the former, 5-208 General Motors Bldg., Detroit, Mich. Second edition. Price 25 cents*—A 20-page pamphlet showing by charts, diagrams and formulas complete test methods for fans and blowers.

# High Efficiency with Poor Coal

*By J. G. Worker**

*American Engineering Company*

**Water cooling, air zoning, better tuyere design, enable modern stokers to burn a wide variety of low-grade coals at high rating and efficiency**

COAL is the major item of expense in steam generation. If coal is costing $5 a ton and a coal is offered at $4, fuel costs are reduced by burning the cheaper coal if no more expense is created in its burning. In the past, however, the cheaper-grade or low-fusion-ash coals have created so many difficulties that in many cases it was decided to go back to the higher-priced coal.

Savings can also be made by using equipment to get the maximum steam out of the boilers. Assume a plant is providing 150,000 lb. of steam per hr., and 275,000 lb. per hr., is needed. If the present equipment can be speeded up sufficiently without loss in economy or convenience it is obvious that money will be saved.

If engineers were called upon to design an ideal fuel burning equipment, what fundamental specifications would such a unit measure up to, and what determines the relative value of the individual items in these specifications? The following list of factors, arranged in the order of importance is submitted:

1. Reliability
2. Capacity
3. Maintenance
4. Flexibility
5. Fuel Flexibility
6. Efficiency
7. Operation
8. Adaptability
9. Refuse
10. Stack Discharge
11. Space Requirements
12. Obsolescence
13. Price
14. Other Considerations

That progress has been made toward the solution of these problems is indicated by performance of some of the more modern stoker installations. Efforts have been made and are still being made to produce stoker-fired steam generators that will function up to full capacity for 50 out of 52 weeks. Stokers must finally be designed to operate this long. This degree of reliability is also necessary very frequently to justify the investment. Figures indicate that a gross return of 25% to 30% can only be shown when a reliability factor in excess of 90% is attained.

In older designs, soft ash sometimes chilled at a level above the air openings in the grate. When this happened it acted as a binder in the fuel bed, reducing the area of fire through which air could pass. Since the same quantity of air must pass to sustain the output desired, the reduction in area resulted in increased air velocities.

It will be seen that equalizing and controlling the burning rate over the entire area of the stoker is essential to sustained high capacity. The water cooling of the stoker accomplishes this by instantaneously chilling the ash in small pieces rather than cooling it slowly. For these reasons the fuel bed on a water-cooled stoker is more homogeneous and burning rates are better equalized.

Developments have also been made in tuyere design so that the flow of excess air to a weak point in the fuel bed is restricted, and as a result air flow through the entire fuel bed is better distributed.

Fig. 2 shows a cross-section through a typical fuel bed of a multiple-retort stoker with the green coal in the troughs or retorts moving upward and over the tuyeres as the fuel moves down the grate. The chart above this cross-section, shows the pounds per square foot per hour of coal burning above each section. At the right-hand side, a normal fuel bed is burning 60 lb. per sq.ft. per hr., and on the next section is a thin fuel bed through which sufficient air passes to burn 165 lb. of coal per sq.ft. This represents the condition existing in the past.

Research on air control and distribution has developed a way to limit the flow of air to thin spots in the fuel bed so that the coal-burning rate at these spots will be only 106 lb. instead of 165 lb. In actual practice, this system has a marked effect on the behavior of the fuel bed, by limiting the maximum combustion rate in spots, it raises the average for the whole fuel bed. Increases on the order of 30% or more in the average coal burning rate can be maintained quite easily. Thus the output from a stoker of given grate area can be materially increased with a corresponding improvement in efficiency.

The air control, Fig. 1, divides the surface of the stoker into a large number of small areas and separately measures and controls air flow to each. In some cases the control is handled manually, in others automatically.

*Abstract of paper presented before Engineers Society of Western Pennsylvania.

Fig. 1. Zoned air control

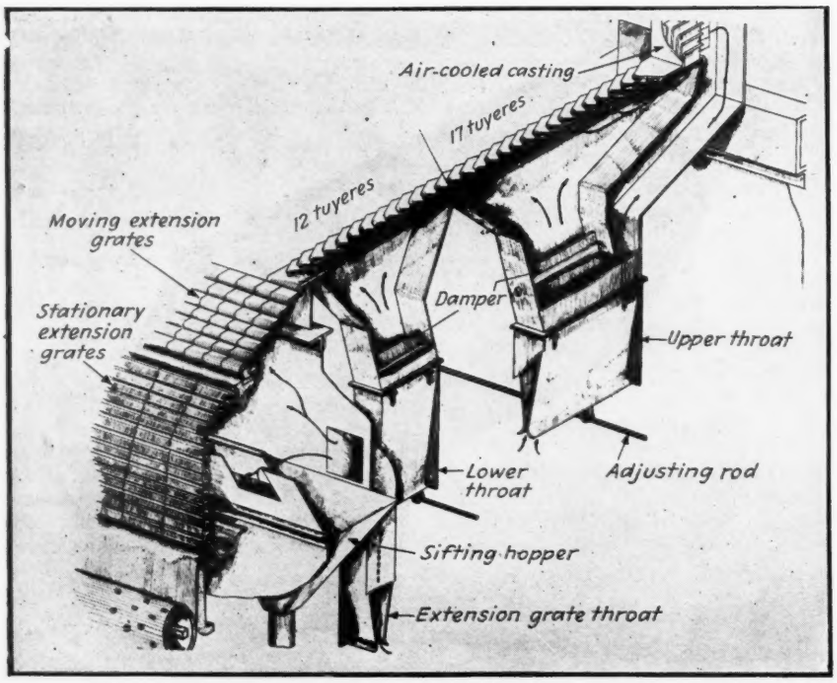
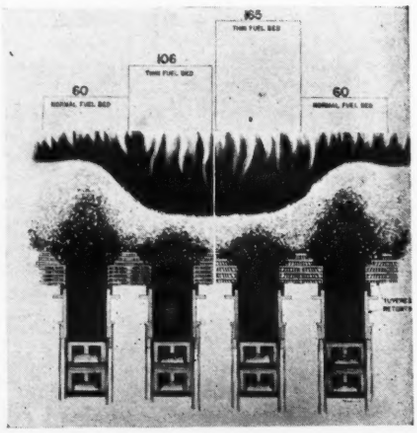



Fig. 2 Fuel bed of underfeed stoker



Reducing cost and time required for maintenance is closely related to reliability. Recent designs have materially extended the amount of water cooling used in furnaces. It has been extended to cover the entire top surface of the fuel supporting area of the stoker, preventing fused ash from the air admitting openings. When these openings are closed and normal flow of cooling air interrupted, furnace parts may be destroyed. Water cooling eliminates this trouble.

Ability to follow steam demand quickly is an inherent advantage of underfeed stokers. The large reserve of coked coal in the fuel bed can be burned at the operator's will by regulating air flow. Strides

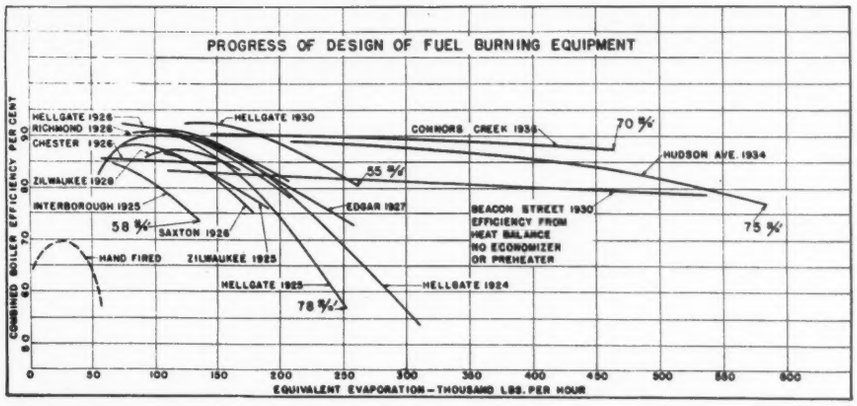



Fig. 3. Progress of design

Fig. 4. Operation of slag drip

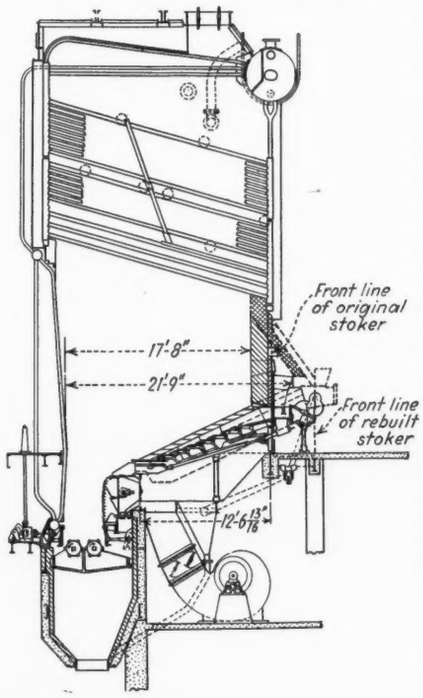
that have been made toward a more homogeneous fuel bed and better air-flow control afford still further flexibility.

An important characteristic of coal from the standpoint of its use in modern steam generators is ash fusing temperature which affects the fuel bed and efficiency of the passages in the boiler and superheater. Water cooling has modified this problem. At the higher burning rates tuyere design and air control reduce localized high air velocities and the tendency toward slag formation. Other characteristics of coal such as moisture and volatile content are not a serious problem. The underfeed method of fuel introduction distributes these portions of the fuel under and through the entire area of the fuel bed. Ignition can be maintained at all ratings regardless of the amount of water cooling in the furnace.

Fig. 3 shows the efficiency of various installations from 1925 up to the present time. Maximum efficiency has not changed materially. The curves are flatter, however, and high efficiencies are maintained over a wide range of output. This results directly from progress made toward fuel bed equalization. Efficiencies were formerly reduced at the higher ratings due to the various fuel bed disturbances that have been described.

Operation at high capacities with high efficiency has been simplified. Facilities for the correction of fuel bed conditions have been brought to the front end of the stoker. Modern tuyere designs and air control automatically modify the attention formerly required and reduce the number of corrections. Gages measuring air flow to individual areas of the stoker surface enable the operator to visualize fuel bed conditions.

Fig. 5. 90,000 to 125,000 lb. per hr. by modernizing and lengthening




## Fly-Ash

The small amount of fly-ash discharge from the stoker-fired steam generator is not objectionable and is of such a size that it can be collected comparatively easily and inexpensively. The bulk of the ash remains on the grate and is automatically discharged. These ashes are smaller than formerly and can be conveniently and cleanly handled. Frequently they have a sales value.

When coal is burned on an underfeed stoker, it remains practically stationary on the grate. Consequently, a large furnace is not essential to the complete combustion. This makes possible the production of a large quantity of steam with a relatively small consumption of space and volume. Hudson Avenue tests show about 2020 lb. of coal burned per hr. per ft. of furnace width for maximum continuous capacity. Furnaces are 26 ft. wide and have 694 sq.ft. of projected grate area.

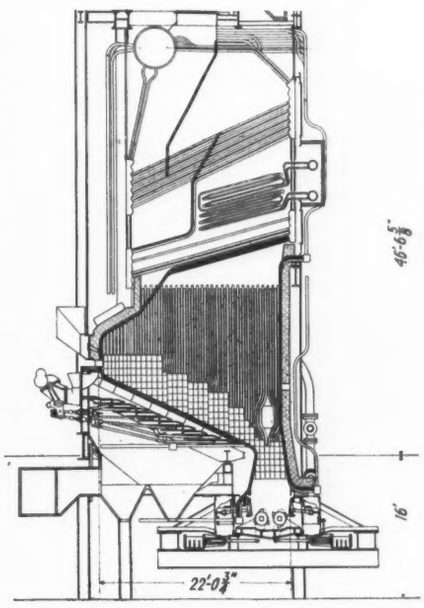
## Underfeed Principle

The underfeed principle has always been considered an efficient way to burn coal and has remained fundamentally the same from the time of its inception. It has been modified, however, to keep pace with the developments in the art of fuel burning. There are numerous examples of old boilers that have been equipped with new underfeed stokers from time to time. The performance of these modernized units compares favorably with all new equipment.

Price is an important factor when designing equipment. It does not necessarily follow, however, that low price is the wisest decision. During its life it will burn fuel having a value many times the original cost and often a slight increment in original price is offset by improved performance of more expensive equipment.

Progress in design and modernization of stoker-fired steam generating units is shown in the other illustrations.

Fig. 6. Water-cooled stoker in Middle West central station



# A. I. E. E. Convention Includes Fifty-five Papers

**Short-time overloads on transformers, new type electrostatic dust precipitator, electronic voltage regulator for d.c. generators, self-regulated compounded electronic-tube rectifier, abrasive as a factor in electrical brush wear, and arc characteristic applying to flashing on commutators among subjects discussed**

THIS YEAR'S winter convention of the American Institute of Electrical Engineers, in the Engineering Societies Building, New York, N. Y., Jan. 25-29, initiated a return to a 5-day schedule. Success of the convention substantiated the judgment of those who planned it on a "pre-depression" proportion. Registration began Monday morning, with an opening session in the afternoon, followed by technical sessions morning and afternoon for the next three days. Friday, the fifth day, was devoted to engineering inspection trips. Presentation of the Edison Medal to Alex Dow, president of Detroit Edison Co., on Wednesday evening, as reported in February *Power*, was an outstanding event.

At the 13 technical sessions 55 papers, dealing with insulation, power transmission and distribution, lightning protection, electrical machinery, transformers, instruments, protective equipment and welding were presented and discussed. Several are of interest to operating engineers.

"Proposed Transformer Standards", by J. E. Clem, gave a short-time heating and overload guide for distribution transformers. This guide states that distribution transformers operate under varying loading time curves, generally with relatively low load factor. Because of these conditions, it is possible to apply higher than rated load for short periods without encroaching too seriously on insulation or oil life.

A curve representing the magnitude and duration of permissible daily overload, starting at no-load temperature, has been compiled and is shown as that portion of Fig. 1 for periods longer than 5 min. by curve *B*. This section of the curve should be of value in the application of distribution transformers, particularly in determining the economic size required to carry the expected load with due regard to short-time peak loads.

The short-time portion of the curve, that is, for periods less than 5 min., curve *A*, is based in general on what may be termed short circuits, the occurrences of which are accidental, not predetermined as with a daily recurrent load. Curve *A* will be useful in the application of primary fuse links or network transformer fuses to meet thermal-protective requirements. It may also be used to determine the ability of a distribution transformer to operate as grounding transformer only and to indicate the required time and current setting of a protective device in the neutral to clear the transformer in case of sustained faults. These curves are blended to form a composite continuous curve based on the limiting condition of a 30-deg. daily average ambient. For lower ambients, the same increase of load may be permitted as has been standardized for power transformers, 1% for each degree below 30 deg. C., but no further increase shall be made below a temperature of 0 deg. C. Continuous duty on distribution transformers in high ambients is so unusual as to constitute a special situation which should be presented when transformers for such service are purchased.

G. W. Penney described a new type of electrostatic precipitator that eliminates some of the factors limiting the use of previous designs, such as direct-current voltages of from 30,000 to 100,000 volts, and appreciable clearance required; and large space required. The corona discharge generates so much ozone that cleaned air is too irritating to the nose and throat to be used for ventilation; and first cost and maintenance are both high as compared to other types of cleaning equipment. The new type is comparatively small and operates on voltages of 12,000 to 14,000 volts.

A generator-voltage regulator using grid-controlled arc-discharge tubes as rectifiers under the control of a diode to supply field current for d.c. generators was described by F. H. Gulliksen. The regulator has demonstrated an over-all sensitivity of plus or minus 0.5%, and is comparable in cost to the usual electromagnetic regulators, but requires an a.c. source. It was tested with a 5-kw., 125-volt, 1,750-r.p.m., d.c. generator having a field resistance of 87 ohms, and a field current at no load of 0.92 amp. When the generator was connected as a shunt machine the regulation from no load to full load was as shown by curve *A* Fig. 2. With the regulator in control and connected for zero compensation, it had a drooping characteristic, curve *B*. With compensation, regulation from no load to full load was practically a straight line, curve *C*. Tests were also made with the series field of the generator connected to give partial compounding, and when the compensating adjustment was used the regulator had a slightly rising characteristic, as shown by curve *F*. It was suggested that the regulator is superior to most types of electromagnetic regulators in regard to increased sensitivity, speed of response and reliability and decreased maintenance, and that it should prove useful in d.c. regulator application where an auxiliary a.c. source is available, such as a.c. motors driving d.c. generators.

By means of the grid-control circuit, described by W. Melvin Goodhue and R. Burton Power, a power rectifier can act as its own automatic regulator without a vibrating contact. At the same time the circuit may be compounded with respect to load current and input voltage,

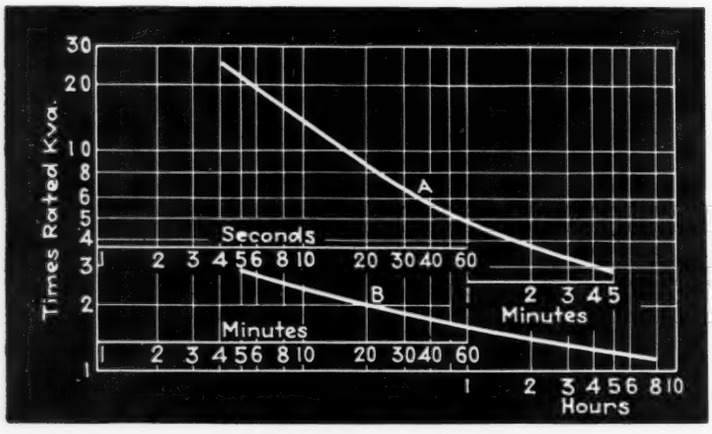



Fig. 1—Curves of allowable short-time overloads on distribution transformers

giving a wide variety of characteristics ranging from cumulative compound to constant current. These characteristics cover a wider range than do those usually obtained from d.c. generators. Furthermore, the automatic control is nearly instantaneous, which is not true of d.c. generators or vibrating- and thermal-type regulators. Compared with electronic regulators, the simplest of the circuits has the advantages of not employing auxiliary tubes, which will greatly lower the cost of small installations. Control equipment is practically inertialess, therefore almost instantaneous in operation.

### Brush Wear

The result of a series of experiments in which the processes of contact voltage drop and ring wear in sliding contacts were demonstrated by means of a direct method were presented by R. M. Baker and G. W. Hewitt. These tests show that wear of metal-graphite brushes and the rings upon which they operate can be reduced if they are operated in an oxygen-free gas instead of air. Maximum ring wear occurs on those sections where the current flows from ring to brush and minimum wear, where current flows from brush to ring. These observations agree with the fact that in d.c. operation, negative-ring wear is much greater than that of the positive ring.

Previous experiments have shown that carbon brushes wear very slowly when operated in hydrogen atmosphere. This led to the belief that oxygen in the atmosphere was responsible for brush wear commonly observed in service and that this wear could be reduced greatly if brushes were surrounded by some oxygen-free atmosphere.

A test made in dry oxygen with no current in the brushes indicated a brush wear of 8 in. per year, greater than in commercial oxygen with current flowing. The high rate of wear was due apparently to the extreme dryness of the oxygen, for when some moisture was purposely introduced the coefficient of friction decreased about 50%, and the rate of wear became 2.8 in. per year. In dry carbon-dioxide the rate of brush wear, with current flowing, was only 0.028 in. per year. It then appears that the brush wear, with no current flowing in the brushes, is about 100 times greater in oxygen, under the most favorable conditions, than it is in dry carbon-dioxide.

The noticeable effect of moisture in reducing brush wear during operation in oxygen is just opposite to that during operation in oxygen-free gases. From this it appears that moisture is beneficial during oxygen operations and perhaps also during air operations, for it results in decreased friction and a lower rate of brush wear. This is in line with field experience, where short brush life is often associated with low air humidity.

An investigation of the effects of abrasion upon brush wear was reported in "Abrasion—A Factor in Electrical Brush Wear," by V. P. Hessler. Tests of the rate of wear of positive and negative brushes, and of brushes carrying current, and those that did not, show that abrasion is an important factor. Experiments include conditions of brush tracking and brush trailing. With brushes tracking, positive and negative brushes are both operated on the same path, while with brushes trailing, a brush not carrying current is operated on the same path with a current-carrying brush.

Results showed that brush wear is largely abrasion resulting from a ring surface condition set up by current flow. In general, the trailing brush wears at almost the same rate as the current-carrying brush. In several instances, trailing metallic brushes wore more rapidly than the current-carrying brush.

After brush wear was shown to be largely abrasion, it was thought that it might be reduced by burnishing or polishing the rings continuously. This was attempted with a cotton tape, and reduced the wear by about 60% in the first test. However, it was not possible to obtain these results consistently. An attempt to obtain better results with the aid of fine abrasives resulted in a large increased rate of brush wear.

The results suggest using metallic and non-metallic brushes on the same path to reduce brush wear, but no commercial machine seems to be adaptable to such an arrangement. Principal findings are:

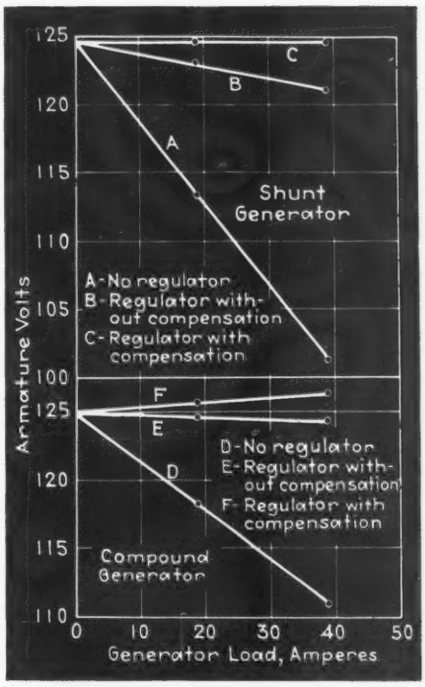



**Fig. 2—Regulation curves for d.c. generator without and with series-field winding**

1. Wear of brushes on concentric rings is largely abrasion resulting from a ring condition established by current flow.

2. The abrasive ring condition is caused by the negative brush for carbon- or graphite-brush material, but is caused by the positive brush in the case of metallic-brush materials.

3. The abrasive action of the positive metallic-brush path is much more pronounced than that of the cathode carbon or graphite brush path.

Results of experimental investigations relating to arc characteristics as they apply in commutator flashing were presented by R. E. Hellmund. This paper is of particular interest to designers and is an extension of the author's work given in a previous paper, dealing with a method of analyzing flashing on commutators caused by jumping of the brushes.

# EXHAUST LINES

## By E. J. Tangerman

*The Japanese have just announced a spring-driven automobile, capable of running 9 miles on a winding. You plan your drive so you're at a rewinding station when the spring runs down. That's one car that won't run with a broken spring!*

Shoreline Refining Co., Lewis, La., is delivering both crude oil and gas through its pipe line. The 4-in. line draws from high-pressure traps into which the wells deliver. Another pressure trap at the refinery takes the gas out. As much as 4,000,000 cu.ft. of natural gas a day are passed through for refinery service.

*Six American companies specialize in removing chewing gum from theatre seats, and 11 sell 2nd-hand gum. 27 times more money is spent for gum than for books.*

Auto trucks with charcoal-gas generators are cheaper than gasoline-driven units, says the Vancouver Laboratory of the Forest Service Branch, Dominion Dept. of Mines & Resources (Canada). Considering gasoline at 30 cents a gallon (remember—this is in Canada!) and charcoal at $20 a ton, Douglas fir cordwood shows lowest price at 24 cents per ton-mile (on a 1½-ton truck), red alder 25 cents, lodgepole pine 27 cents, cottonwood 30 cents and gasoline 57 cents. Douglas fir is so dusty that it necessitates frequent cleaning of the producer; alder and cottonwood are clean, softwood charcoal (pine) is soft, coarse and tends to crumble. Relative ton-miles per lb. of charcoal are: Douglas fir, 4.2; red alder, 3.9; lodgepole pine, 3.7; Douglas fir edgings, 3.4; cottonwood, 3.3; Sitka spruce, 2.9.

*Here's a new idea in elevators—and it's going in in Czechoslovakia, in that country's first skyscraper. Bata A.S., huge shoe manufacturer, is putting in a 15-story office building, in which the executive office is really a spacious elevator car that can be raised or lowered to any desired floor. Instead of calling you up on the carpet, they bring the carpet down to you.*

*Manufacturing is the largest industrial source of national income. Last year it totaled about $12 billion, 80 to 85% as salaries.*

# A.S.H.V.E. Meets at St. Louis

AT THE 43rd annual meeting in St. Louis, Mo., Jan. 25-27, about 500 members of the American Society of Heating & Ventilating Engineers turned to performance of heating systems, design of ventilating systems, and air conditioning.

New officers of the A.S.H.V.E. are: Davis Boyden, of Boston, president; E. H. Gurney and J. F. McIntire, vice-presidents; and A. J. Offner, treasurer.

At the first technical session a paper by M. C. Stuart and J. B. Lusk described a new method for selecting fans which employed "specific characteristics," instead of quantity-head characteristics.

Basically, specific characteristics show for a given fan type variation of size, speed and efficiency when the system external to the fan is fixed, thus establishing volume and head.

Specific diameter of any fan operating at a given efficiency is the diameter of a geometrically similar fan which, running at its corresponding specific speed, will deliver 1,000 c.f.m. at 1-in. head at the same efficiency. Specific diameter, specific speed, and specific tip speed are more or less interrelated, and equations for each are given, together with curves of these values plotted against efficiency for 8 fan types. From specific characteristics, size and speed of the same type fans required to produce various quantities and heads may be determined by applying relations shown in the paper.

When fan speed is fixed, specific speed is established, because in this case quantity, head and speed are all fixed. This fixing of specific speed limits choice of fan to those having good efficiency at known specific speed. Diameter required can then be computed from specific diameters corresponding to specific speeds. Fixing fan diameter or tip speed similarly fixes specific diameter and specific tip speed, permitting a choice of fan.

An actual example shows how this method is applied to fan selection.

Prof. R. L. Perry mildly criticized the paper in the discussion because the method outlined is based on static head. Professor Perry maintained that the method should have been based on total head. S. H. Downs pointed out that, unlike the curves shown in the paper, efficiency curves of fans usually have a broad top and not a short peak. This being the case, it is possible to make the wrong selection in some instances.

In a written reply to Professor Perry's comments, the authors agreed that selection based on total head is frequently desired, but that the purpose of the paper is to acquaint engineers with the specific characteristics idea and that in many cases static head alone is important.

"A Rational Method of Duct Design" was given in a paper by L. G. Miller. Before the problem of duct design can be approached, such items as design and location of grilles, quantity of air to be circulated and location of fan and conditioning equipment must be determined. The method outlined and illustrated by an example is a combination of the velocity method and the friction-pressure-loss method given in the A.S.H.V.E. *Guide*. The only velocities arbitrarily assigned are in cases where high values lead to noise turbulence or duct vibration. Remainder of the system is designed for equal over-all pressure drop without adhering to any specific pressure loss per ft. length.

Noise is one of the first considerations in specifying a suitable grille for an air-supply outlet in a ventilating system. In "Noise Characteristics of Air Supply Outlets," D. J. Stewart and G. F. Drake discussed noise from supply outlets and permissible noise level added by grilles. Results of studies and tests of noise level from various grille types and sizes and with different air velocities are described and the method presented for grille selection that will keep noise levels below an objectionable value.

Experience indicates that an increase in noise level of 1 decibel (at about 30 d.b.) can hardly be detected, but that a 2-d.b. increase can be detected. If a ventilating fan is started and stopped during occupancy, an increase of more than 1 d.b. is usually objectionable. This requires that noise level of the grille be about 5 d.b. below the noise level of the room without the grille. However, if the fan runs continuously, an addition of 3 d.b. or even more is often entirely unobjectionable. Discussion of this paper brought out that the curves given referred to a horizontal fin type and that grille height has an effect on noise level.

Another paper on noise in ventilating systems by J. S. Parkinson was presented by Mr. Patterson. Noise in ventilating systems has three general sources, the motor, the fan, and air itself. The motor generates frequencies which are related to rotational speed and electrical frequency. The fan may generate sounds which are a function of its rotational frequency, and which are multiples of blade frequency. Air moving past roughnesses or obstructions gives off high-frequency sound. There may also be noise generated at outlets because of faulty grille design. A fairly representative range in noise level from the outlet of an untreated system is 55 to 75 d.b.

The paper reports data from tests which show that when air speed was increased by increasing fan speeds, noise level increased. But increasing air speed by making intake openings larger hardly affected noise level.

Vibration can be prevented from telephoning through the walls of a duct by using suitable flexible connections between fan and ducts. Fan and motor should be separated from the building structure by vibration-insulating mountings. Fan speeds should be kept as low as possible and equipment should be well balanced and free from excessive vibration. Large duct sections should be braced to avoid resonance. Construction should be designed to avoid unnecessary turbulence. Sound absorbing lining may be placed inside the duct. It should have high absorbing efficiency, below 50 cycles.

A particularly important paper to those interested in air conditioning was "Cooling Requirements for Summer Comfort Air Conditioning," by F. C. Houghton, F. E. Giesecke, Cyril Tasker and Carl Gutberlet. This work has been carried on at the Societies Research Laboratories in Pittsburgh, the A. & M. College of Texas and Ontario Research Foundation.

These studies were designed to determine among other things: variation in the desirable conditions for comfort in summer air conditioning with geographical locations; variation in relative humidity of air at constant effective temperature; and variation in effective temperature required for comfort caused by age, sex and general health conditions.

Results clearly showed that an effective temperature 2 to 3 deg. F. lower is required for comfort in Toronto than in Pittsburgh, while Texas requires the same effective temperature as Pittsburgh. In Toronto, 70% of subjects were found to be comfortable over a range of effective temperatures from 68.05 to 71 deg.; in Pittsburgh from 69.5 to 74 deg. and in Texas from 71 to 74 deg. Work carried on at a constant effective temperature of 73 deg. indicated that no measurable variation exists in the time required for perspiration to disappear and for comfort to be established in a relative humidity range of 20 to 90%.

D. W. Nelson reported results of tests to determine rate of condensate and air-removal from a vacuum heating system performed at the Mechanical Engineering Building, University of Wisconsin. Heating system of this building has connected 38,782 sq.ft. of equivalent direct-radiation, about 30,500 sq.ft. of which is active. During normal operation, condensate load is 2,614 lb. per hr. and air removal 87.6 cu.ft. per hr., a ratio of 0.024 cu.ft. of air per lb. of condensate.

Under peak-load conditions obtained by turning steam into the cold system (taking 30 min. to open the steam valve), peak for air removal (1,825 cu.ft. per hr.) was reached in 12 to 16 min. The pump ran continuously on vacuum control for 27 min. removing about 900 cu.ft. of air. Condensate peak of 9,300 lb. per hr. came in 33 min., or 18 min. behind the air-removal peak.

Tests were also run in which the steam valve was opened quickly. A 3-min. air-removal peak of 2,630 cu.ft. per hr. was reached in 6 min. and was largely over in about 15 min. Condensate-removal peak of 6,800 lb. per hr. was arrived at in 15 to 21 min. after cracking the valve, and was over in 39 min. Outside temperature of 49.5 deg. made this peak low.

In discussing this paper, Adams pointed out that, considering the number of sq.ft. of radiators installed, condensate amount was very small, indicating perhaps that the building is over-radiated.

# READERS' PROBLEMS

## QUESTIONS for Our Readers

### Pipe Insulation

**Question 1**

WE *are expecting to paint all pipe coverings in our plant. Can some one tell me what sizing to use on canvas covering and what to do with bare asbestos surfaces before painting?*—E. C.

### Suitable Monometer Fluid

**Question 2**

A *number of monometers measure gas pressure in our plant. Pressures are so high that water can not be used as an indicating fluid and we find it hard to detect slight pressure changes with mercury. Can some reader suggest a fluid having a specific gravity 2 or 3 times that of water and suitable for use in monometers?*—S. C. H.

Suitable answers from readers will be paid for if space is available for publication.

## FEEDWATER HEATERS

**ANSWERS to January Question Number 1**

**The Question**

IN OUR PLANT *we have a large deaerating feedwater heater with a vent condenser designed for an inlet-water temperature of 60 deg. F. In our case, however, water enters the heater at 190 deg. F. A great deal of steam seems to be wasted through the atmospheric escape pipe of the vent condenser. Can we reduce this loss by putting a thermostatic air valve in this line? What is the best way of controlling the temperature in this heater? Should we use a pressure- or temperature-controlled makeup steam valve, and if so, where should the pressure control line or temperature-control actuating bulb be located?*—J. P. C.

### Use Pressure Control

EXCESS or insufficient steam venting can be determined only by chemical tests on the heater-output water for measurement of dissolved-oxygen concentration. Such tests should be made, if possible, in this case, as in all cases. Test procedures are given in "Standard Methods of Water Analysis", Ed. 8, American Public Health Association, New York, N. Y., 1936.

Reduction in heat absorption of the vent condenser is likely to cause poor deaeration of the water. If steam escaping from the condenser is now excessive, it must certainly have been much too great with the same orifice when vent condenser water was colder. It is, perhaps, needless to point out that the fog plume spouting from deaerator opening may appear to indicate a large steam loss when only humid fixed gas is escaping.

Air valves are used on deaerator vents when water-flow rate is decidedly variable or when deaeration is at a pressure considerably above atmospheric.

Precise pressure control of live steam is usually more easily worked out than temperature control. Pilot connection or pressure tap should lead directly from deaeration chamber, should be independent of all other connections to the deaerator, and must not be in line with steam or condensate inlets. A siphon or water seal in a pilot line to a pressure-reducing valve should be carefully designed to obviate any appreciable change in the seal water level with operation of the valve.

*Corvallis, Oregon* R. E. SUMMERS

### Add Surface to Vent Condenser

IN ORDER that a deaerating heater may function efficiently, it is essential that steam space be kept free of non-condensable gases. This is accomplished by removing sufficient steam to sweep away these gases as fast as they are liberated.

Reducing the amount of steam withdrawn below that necessary to thoroughly clear heater of gas may result in building up a partial pressure in heater, which will stop its functioning as a deaerator. Any attempt to restrict steam flow from the vent should be accompanied by a check to see that feedwater temperature has not been reduced nor its oxygen content increased.

Heating surface of the condenser and size of vent connections should be proportioned so that, with an incoming water temperature of 60 deg. F., there will not be over 40 or 50 deg. temperature rise (to prevent tendency of scale formation on tubes) when all of vented steam has been condensed. Consequently, heating surface provided to condense required amount of steam when inlet temperature of cooling water is 60 deg. will be inadequate when this temperature is raised to 190 deg. It would, therefore, seem desirable to provide additional surface in the vent condenser rather than reduce steam withdrawn from the heater.

Additional condensing surface could be provided by piping steam discharged from the vent to any suitable heat-exchange apparatus, such as a water heater, pipe coil, radiator or unit heater. The device used should have a free outlet to allow disposal of the non-condensable gases present. Pressure control of makeup steam is preferable in the average plant. Steam needed with an inlet water temperature of 190 deg. is approximately one fifth of that needed when the water temperature is 60 deg. Therefore, if piping is large enough, the regulating valve may be placed conveniently without appreciable pressure drop between it and the heater.

*Clyde, N. Y.* JULIUS BRODSKY

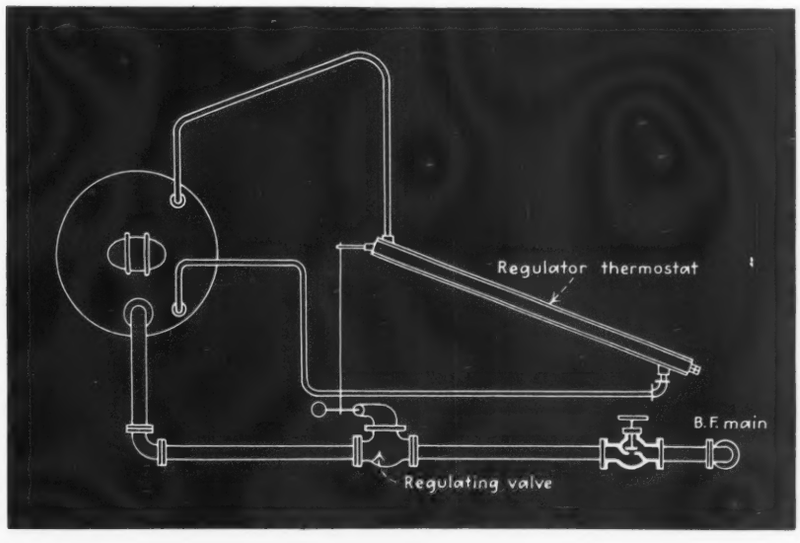
### Use Larger Condenser

STEAM pressure maintained in the deaerating feedwater heater is not mentioned, but assuming that it is 3 lb. gage, feedwater should be heated to the saturated steam temperature of 222 deg. F. when the heater is properly vented. A vent condenser is usually furnished to handle cold makeup water through tubes to condense gas and relieve non-condensible gas to atmosphere through a thermostatic valve or properly "cracked" globe valve. It appears, however, that this particular vent

## WHAT'S WRONG WITH THIS PICTURE—XIII

**Boiler Feedwater Connections**

THERE are at least 10 mistakes shown in this drawing. Make a list of them you recognize, then check against the list on page 168.



condenser is handling hot returns at 190 deg. Since the temperature differential is only 32 deg., it is clear that tube surface in the vent condenser is sufficient because it was originally designed to handle 60-deg. water with an approximate temperature differential of 162 deg.

Vent condenser should be replaced by a larger unit based on these factors:

Maximum lb. per hr. of water to be delivered by heater.

Temperature of water desired at heater suction.

Steam pressure carried in heater shell.

Lb. per hr. of makeup water. Temperature and pressure.

Lb. per hr. of condensate returned. Temperature and pressure.

If it is impractical to replace present vent condenser with a larger unit, it may be possible to rearrange piping connections so that cold makeup water passes through the condenser and 190-deg. water enters the heater direct.

When a vent condenser is properly designed and operated, only non-condensible gas should be vented to atmosphere. Installation of a pressure- or temperature-controlled makeup-steam valve with actuating bulb would not be advisable in this case unless feedwater temperature is to be reduced by installing a pilot-operated control valve in exhaust line to heater. This should be done only when it will not upset the heat balance.

*Milwaukee, Wis.* W. J. TAYLOR

## Increase Condenser Surface

Quite frequently changes in operating conditions from those for which a deaerating feedwater heater is designed bring about troubles such as J.P.C. presents in Question 1, January *Power*.

A vent condenser is essentially an automatic valve intended to reduce steam-air ratio and bring about separation. Designed for 60-deg. inlet water temperature, J.P.C.'s vent condenser is about 25% of the size required for 190 deg.

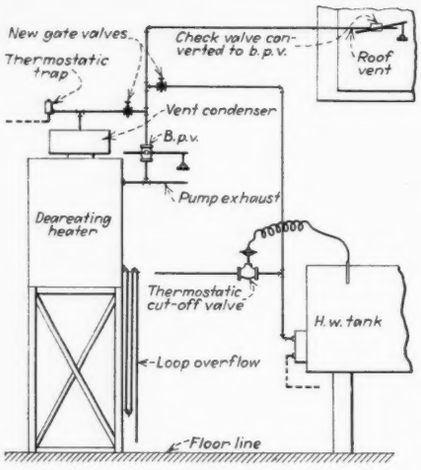
An air-vent valve will not compensate for lack of vent condenser surface. Therefore, the best procedure is to install a vent condenser with about 4 times the surface of the present one. Water velocity should be kept at about the same figure; hence, the new condenser would have more passes in the water circuit.

Vents from a vent condenser should not, under ideal conditions, blow steam. Changes in load, etc., cause a slight blow. J.P.C. should put a globe valve in the vent line, drill this valve disc with a $\frac{1}{8}$-in. drill and shut the valve. Next he should observe the exit of vent line and if necessary open the valve so that a "feather" of steam is noticed at all times.

Water leaving the deaerating-tray section should be at steam temperature to remove all dissolved oxygen. Hence, temperature control of make-up steam would be rather difficult.

The best way, therefore, to control make-up steam is by pressure control. Have live steam tied into the exhaust header through a reducing valve. Needless to say, ample relief protection should be provided to prevent too high pressure in the heater and exhaust piping.

*Los Angeles, Calif.* W. R. DUNN
*Elliott Co.*




## Recommends Thermostatic Valve on Vent

WE HAD a condition in our plant similar to J.P.C.'s, and in addition to steam waste through the vent condenser, a reciprocating pump caused more waste through the back-pressure valve. Because the deaerating heater has a loop overflow, it was almost impossible to adjust the back-pressure valve.

As a solution we placed a gate valve between the condenser and roof vent and a thermostatic vent-valve to vent the heater. Also we converted a discarded check valve to a back-pressure valve and installed it on roof vent. Then made a connection mid-way between the two back-pressure valves into a hot water heater, between tank heater and thermostatic cut-off valve. These changes are shown in the illustration above.

The deaerating heater has been giving perfect service, with feedwater at 212 deg. F., and not even a whisp of steam escapes. The savings, because of this change, were 316 lb. of steam per hour. Cost of change, labor and material, $32.

F. D. HAYS
*Macon, Ga.* *Wesleyan College*

## PROTECTING DOUBLE-PIPE AMMONIA CONDENSER

**ANSWERS to January Question Number 2**

**The Question**

OUR *double-pipe ammonia condenser is on the roof in a very exposed place. It freezes every year as soon as we get zero weather. Could we run it as an atmospheric condenser during the winter, without making any changes except running the water on the outside of the pipe? The condenser has seven stands* 18 *ft. long,* 12 *pipes high. Outside pipes are* 2 *in. in diameter, and the inside pipe is* $1\frac{1}{4}$ *in. About what capacity can be expect, if used as an atmospheric condenser?*—E. M.

## Reports No Difficulty With Atmospheric Condenser

THE proposal to operate a double-pipe ammonia condenser as an atmospheric condenser is feasible. We operate a refrigeration system in which condensing apparatus includes 20 stands of 24 2-in. pipes each and two vertical shell-and-tube condensers. This equipment is under a roof, but open on two sides, and under certain conditions of load and outside temperature, little or no water is used by shell and tube condensers, and none by the stands, which

## WHAT'S WRONG WITH THIS PICTURE—XIII

**Boiler Feedwater Connections—See Page 167**

THIS "What's Wrong" shows errors in piping feedwater at the boiler and in connecting and locating a feedwater-level regulator.

*1. No Check Valve at Feedwater Inlet.* The A.S.M.E. Boiler Code provides that a check valve shall be placed in the feed piping close to the boiler. This prevents water from flowing out of the boiler in the case of pump or pipe-line failure.

*2. No Stop Valve at Feedwater Inlet.* A stop valve is required by the Boiler Code between the check valve and the boiler. A combination stop and check valve is often used to meet this requirement.

*3. Only One Source of Feedwater.* Boilers with more than 500 sq.ft. of heating surface are required by the Code to have two means of feeding.

*4. No Bypass Around Feedwater Regulating Valve.* A bypass with a valve for hand control should be provided around the regulating valve so water can be fed to the boiler in case of trouble with the automatic valve.

*5. No Stop Valves Before and After Regulating Valve.* Stop valves should be placed before and after the regulating valve inside of the bypass so the regulating valve can be isolated for repair without having to shut down the boiler.

*6. Globe Valve Installed Backwards.* Valve should be installed so that feedwater pressure is under the seat so water flow will not stop if disk falls off the valve stem.

*7. Thermostat Tube Improperly Placed.* Thermostat should be placed so its center line is at the same elevation as normal boiler-water level.

*8. No Valve in Water Line to Thermostat.* A stop valve should be placed close to the boiler in the water line to the thermostat so the regulator can be shut off.

*9. Waterline to Thermostat Contains Pocket.* A pocket in the water piping to the thermostat prevents the water level in the thermostat from following the boiler-water level and prevents proper operation of the regulator.

*10. No Valve in Steam Line to Thermostat.* A valve should be placed in the steam line to the thermostat so the regulator can be shut off.

handle most of the load. The purge line is given a small steady run of water at all times but the total reduces to 66 cu.ft. per ton compared to 217 cu.ft. per ton during the warm weather.

We have encountered no difficulties whatsoever. It is quite probable that because of small surface area, the double-pipe condenser may require some external water.

*Milwaukee, Wis.* S. G. HILLIARD

## No Trouble Operating Atmospheric Condenser

IN ANSWER to Question 2 in Jan. issue, it has been my experience that in exposed places you can get rather high capacities from double-pipe atmospheric condensers because of high gas velocity in the small annular space between inner and outer pipes and added cooling from cold air and evaporation. With only pressure gages to go by, we arrived at lower condenser pressures in cold weather with rather small amounts of water over condenser.

In one plant we ran without water in cold weather. This unit was in an exposed place, although direct sun rays did not reach it. No changes were made, other than adding water distributors at the top of condensers and draining water from inner pipes.

*St. Louis, Mo.* G. F. KLUGMAN

## Circulate Water Over Part of Stand

THE TROUBLE E. M. has experienced is not a new one, and its remedy has been previously suggested. By circulating water over the proper number of stands, temperature can usually be kept above freezing. Several conditions should be observed to provide satisfactory operation. Stands should be level to prevent condensing water running to one end of the pipe. Drip fins should be placed between pipes to provide better flow and to prevent high winds from blowing water from pipes. The bottom of the collecting pan should have enough slope to cause quick runoff of water.

Also, remember that condensing water may freeze due to inattention, add measurably to the roof load and pile up. Then when it melts, it will cause damage.

In a clean double-pipe condenser of the size stated, each stand circulating 20 g.p.m. of 70 deg. water and maintaining a condenser pressure of 185 lb., capacity will be 13 tons of refrigeration per stand. Under the same conditions but used as an atmospheric condenser, capacity will be 8 tons of refrigeration per stand. Depending on the pressure maintained and assuming temperature of condensing water to be about 40 deg. the condenser used as an atmospheric type will have a capacity of approximately 10 tons of refrigeration per stand.

*Waynesboro, Pa.* HUGO RICHENBACH

# MANUFACTURER'S BULLETINS

**Temperature & Pressure Control**—Automatic Temperature Control Co., Philadelphia, Pa. 4-page bulletin G-11 describes "ATC Balancer" temperature and pressure control with load compensation.

**Diesel Engines**—Busch-Sulzer Bros., St. Louis, Mo. Two bulletins; one a 12-page reprint from *Railway Mechanical Engineer*, Sept., 1936, describing installation of a 2,000-hp. unit in an Illinois Central diesel-electric locomotive; the other an 8-page reprint from *Diesel Progress*, Sept., 1936, on Busch-Sulzer diesel installations in ferryboats.

**Water Level Recorders**—Julien P. Friez & Sons, Inc., Baltimore, Md. 4-page mailing piece on model FD water-level recorders.

**Gas Analyzer**—Hays Corp., Michigan City, Ind. 4-page folder showing construction details of "Orsatomat" flue-gas analyzer.

**Furnace Construction**—Geo. P. Reinties Co., Kansas City, Mo. 12-page bulletin No. 101 on sectionally-supported furnace walls and accessories.

**Feedwater Treatment**—Allis Chalmers Mfg. Co., Milwaukee, Wis. 4-page leaflet No. 2243 describes "Akon," an aqueous suspension of iron which absorbs oxygen and precipitates silica.

**Pillow Blocks**—Randall Graphite Products Corp., 609-613 W. Lake St, Chicago, Ill. 24-page catalog gives specifications and installation data on 6 pillow blocks, including a universal-position model.

**Network Equipment**—Allis Chalmers Mfg. Co., Milwaukee, Wis. Illustrated bulletin No. 1184 on low voltage a.c. transformers, disconnecting and ground switches, and network protectors. 8 pages.

**Engines & Compressors**—Clark Bros. Co., Olean, N. Y. Catalog on stationary compressors for diesel, gas and steam engines, electric-driven compressors, portable engine-driven compressors, drilling and pumping engines, and vertical gas engines for driving generators.

**Switches**—I-T-E Circuit Breaker Co., Philadelphia, Pa. 4-page mailing piece No. 1136 on "Klamp-Tite" knife switches for a.c. or d.c.

**Voltage Regulators**—Allis Chalmers Mfg. Co., Milwaukee, Wis. 12-page bulletin 1185 on automatic branch-feeder type. Illustrated.

**Diesel Engines**—Fairbanks, Morse Co., 900 S. Wabash Ave., Chicago, Ill. 24-page pictorial catalog describing present models with applications in marine, portable and stationary service.

**Power Pumps**—Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill. 12-page bulletin No. 6160 gives characteristics and applications of duplex units. Size and capacity tables.

**Electric Tools**—Chicago Pneumatic Tool Co., 6 E. 44th St., New York, N. Y. 48-page catalog 899 on electric drills, sanders, grinders, tappers, etc.

**Electric Motors**—Century Electric Co., 1806 Pine St, St. Louis, Mo. 8-page leaflet on single-phase, induction motors, ⅛ to 40 hp.

**Flowmeters**—Cochrane Corp., Philadelphia, Pa. Bulletin 2094 on mechanical flowmeters for high pressures and temperatures. Illustrated applications and construction details.

**Feedwater Deaerators**—Cochrane Corp., Philadelphia, Pa. 16-page bulletin 2540 describes deaerator guaranteed to deliver oxygen-free feedwater. Illustrated.

**Stokers**—American Coal Burner Co., 155 E. Superior St., Chicago, Ill. Mailing piece on multiple, pneumatic-spreader stoker for water-tube and h.r.t. boilers.

**Insulation Tester**—Roller-Smith Co., 233 Broadway, New York, N. Y. 6-page bulletin describing construction and operation of "Hipot" tester.

**Condenser Tubes**—Revere Copper & Brass, Inc., 230 Park Ave., New York, N. Y. 44-page catalog, a picture story of manufacturing process. Also gives physical property charts of different types.

**Feed Pumps & Condensate-Return Units**—Deming Co., Salem, Ohio. 8-page bulletin 500 describes three electric boiler-feed pumps and condensate-return units. Performance charts.

**Overload Switches**—General Electric Co., Schenectady, N. Y. Mailing piece No. GEA-2369 on automatic-reset thermal overload switches for protecting fractional-hp. motors.

**Welders**—Lincoln Electric Co., Cleveland, Ohio. Three 4-page bulletins Nos. 315, 316, 317 on a.c. motor-driven, d.c. motor-driven, and belted- or direct-driven models, all for 200, 300, 400, or 600 amp.

**A.S.M.E. Publications**—A.S.M.E, 29 W. 39th St., New York, N. Y. 12-page catalog lists publications for sale.

**Pumps**—Economy Pumping Machinery Co., 3431 W. 48th Pl., Chicago, Ill. 256-page pocket-size handbook in two sections: pump classifications and applications possible. Each pump has tables of size, capacity, head, required hp., and cost. Indexed and illustrated.

**Draft Gages**—Bailey Meter Co., Cleveland, Ohio. 14-page bulletin 163 on diaphragm-operated multi-pointer gages. Describes construction and application. Well illustrated.

**Commutators**—Reliance Electric & Engineering Co., 1088 Ivanhoe Rd., Cleveland, Ohio. Folder No. 1205 describes manufacture, testing and inspection of commutators for d.c., 6-pole motors.

**Light-Sensitive Cell**—General Electric Co., Schenectady, N. Y. 16-page bulletin GEA-2467 gives technical and descriptive data. Nine curve-diagrams show operating characteristics.

**Coal & Ash-Handling Equipment**—Fairfield Engineering Co., Marion, Ohio. 56-page Catalog 436 on skip hoists, bunkers and gates, elevators, weigh larries, coal distributors, storage systems, conveyors, feeders, and ash-handling equipment. Well illustrated, capacity and size tables.

**Pumps**—Milton Roy, 2031 E. Madison St., Philadelphia, Pa. Leaflet on small-volume chemical pumps, varying from 10- to 100-gal. capacity per 24 hr.

**Diesel Engines**—Dominion Engineering Co., Ltd, Montreal, Canada. 4-page Bulletin No. 135 on BW1 and BW2 engines, 12 to 34 b.hp. at 900 to 1200 r.p.m.

**Belts**—United States Rubber Products, Inc., 1790 Broadway, New York, N. Y. Folder contains 25 photos showing unusual installations of transmission belts and U. S. Rubber's Passaic, N. J. factory.

**Computing Capacitor Kva.**—Cornell-Dubilier Corp., South Plainfield, N. J. Folder chart for calculating necessary capacitor kva. to correct lead to desired power-factor. Reverse side of table shows amount of current drawn by capacitors and specifies switch size to be used with various capacitors.

**Coals**—Babcock & Wilcox Co., 85 Liberty St., New York, N. Y. 32-page bulletin gives tables of grindability and analysis of many U. S., Canadian and other coals. Grindability determined by A.S.T.M. tentative method.

**Lubrication**—Stewart-Warner Corp., 1826 Diversey Pkwy., Chicago, Ill. 56-page bulletin, "Alemite Controlled Lubrication" presents range of Alemite equipment. Well illustrated with drawings, photographs and diagrams.

**Hose**—United States Rubber Products, Inc., 1790 Broadway, New York, N. Y. 48-page catalogue on all kinds of hose, includes couplings and fittings.

**Water Analysis**—W. H. & L. D. Betz, Chemical Engineers and Consultants, 235 W. Wyoming Ave., Philadelphia, Pa. 32-page booklet on methods, chemicals and apparatus for analyzing and correcting water.

**Handling Equipment**—Lewis-Shepard Co., 175 Walnut St., Watertown, Mass. Small folder No. 321 describes lift and floor trucks, stackers, portable elevators, drum-drain stands, barrel racks and carboy pourers.

**Hoisting Equipment**—Wright Mfg. Division, American Chain & Cable Co., Inc., York, Pa. Catalogue on complete line of Wright hoists, trolleys and cranes. Special section on electric hoists.

**Leather Belting**—Alexander Bros., Inc., Philadelphia, Pa. 32-page catalogue No. A-116 amplified with charts on hp. ratings, belt speeds, and correct distance between pulley centers.

**Electric Hoists**—American Engineering Co., Philadelphia, Pa. 28-page catalogue "A-E-Co Lo-Heed Hoists" describes capacities, hoisting speeds, heights of lift, weights, etc. Well illustrated.

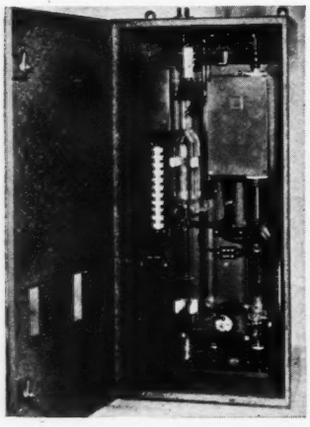
**Lighting**—Benjamin Electric Mfg. Co., Des Plaines, Ill. 32-page handbook, "A Manual of Factory Lighting Practice" discusses 30 common lighting problems found in the average plant and gives recommendations, installation diagrams and specifications for their solution.

**Chemists & Chemical Engineers**—Assn. of Consulting Chemists & Chemical Engineers, 50 East 41st St., New York, N. Y. 60-page directory of association members, with information on officers, staff, laboratories, and scope.

**Monel Metal**—International Nickel Co., Inc., 67 Wall St., New York, N. Y. 48-page pictorial description of Monel Metal's uses in hydroelectric plants, steam generation, turbines, condensing and cooling, pipe lines and refrigeration, among many others.

**Metal Spray**—Metallizing Co. of America, Inc., 1351 East 17th St., Los Angeles, Calif. 36-page booklet, a photographic story of metal spraying and its application.

# WHAT'S NEW IN PLANT EQUIPMENT



### WET GAS $CO_2$ RECORDING EQUIPMENT

A COMPLETE $CO_2$ recorder, using thermal conductivity principle of measurement, in four parts: (1) Recorder, either strip- or circular-chart type. Measuring circuit operates on 110-volt, 60-cycle a.c., range of 0 to 20% $CO_2$. Metal, vapor-proof case for flush mounting. (2) Gas analysis cell cabinet (illustrated here). Includes cell for 0 to 20% $CO_2$, aspirator, metal cabinet and water saturator, gas flow indicator, etc. (3) Primary filter and receptacle. (4) 30 ft. of lead-lined iron sampling pipe and fittings. Filter is mounted in boiler by receptacle permitting filter to be moved for inspection and cleaning. Cell cabinet is mounted near sampling point and connected to filter by lead-lined pipe. Recorder may be mounted wherever desired and connected to cell cabinet with ordinary copper wire.

*Leeds & Northrup Co., 4902 Stenton Ave., Philadelphia, Pa.*

### CIRCUIT-BREAKER MECHANISM

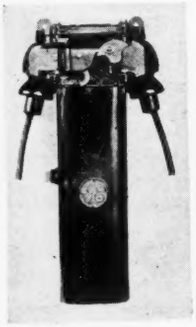
A PORTABLE operating mechanism for "FH" oil circuit breakers has larger opening springs and modified trip-mechanism to reduce friction and shorten opening time. Hydraulic manual-closing device, easily-aligned centrifugal mechanism, and adjustable cut-off switch.

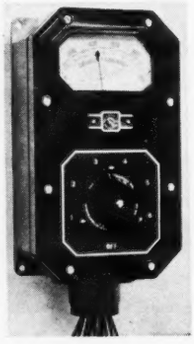
*General Electric Co., Schenectady, N. Y.*

### AIR-FILTER PANELS *(Photo left)*

"AIR-MAZE" panels are alternately spaced flat and crimped galvanized wire screens enclosed in a 16-gage steel frame with open-end lubrication. Stock sizes are 2- and 4-in. thick in 10x20, 20x20, and 16x24 in. Recommended capacity is 2 to 2½ cu.ft. per min. per sq.in.

*Air-Maze Corp., 812 Huron Rd., Cleveland, Ohio.*





### OIL CIRCUIT RECLOSER

FOR 4-amp, 2200- to 7550-volt current, this unit supplements line of "FP-19" reclosers. Automatic adjustment can be made for 1, 2, or 3 reclosures with 3 sec. between operations. If fault is still in line after last reclosure, device locks open. Minimum tripping current 15 amp.

*General Electric Co., Schenectady, N. Y.*

### PORTABLE ARC WELDER *(Photo below)*

A transformer-type welder in four models with capacities from 130 to 300 amp. Has rotary knife-switch control with amperage marked for each welding step. Light-weight wood cabinet. May be used for welding on grounded surfaces without danger to operator.

*Miller Electric Mfg. Co., Appleton, Wis.*

### SWITCHGEAR UNITS

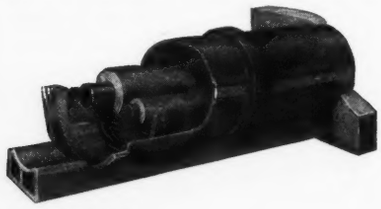
FOR small industrial installations or auxiliary circuits in steam power plants, metal-enclosed switchgear has cubicles in which are mounted breakers, buses, disconnecting switches, instrument transformers and similar auxiliaries. Relays and meters mounted on hinged front panels. Illustrated is a 5-unit structure, with four solenoid breakers behind front panels. Fifth unit has a hand-operated breaker. Wire glass permits inspection of hook-stick-operated disconnect switches in upper compartment.

*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

### DIESEL ENGINE PYROMETER *(Photo left)*

THREE MODELS, for ranges from 0 to 1000, 0 to 1200, and 0 to 1600 deg. F., have 4, 6, 8, 12, 16, or 24 switch points. Integral dial-type switch, molded-Bakelite water-proof case. Said to be extremely rugged and resistant to vibration.

*Brown Instrument Co., Philadelphia.*



### TILE CONDUIT

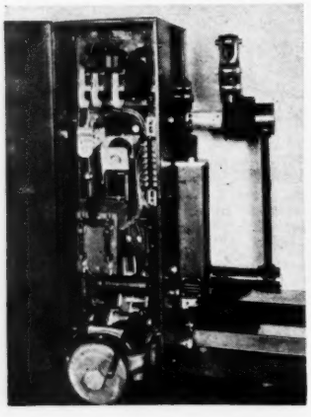
FOR underground steam and hot-water lines, "ADSCO-Bannon" conduit is a base drain supporting a circular, salt-glazed, vitrified conduit with bell and spigot joints in approximately 2-ft. lengths, separable in two halves along horizontal center line. Mortar seal used on joints and projecting lips; sectional asbestos, rock wool, etc., as filter insulation. Sizes to accomodate one or more pipes, with or without insulation. Bulletin No. 35-67.

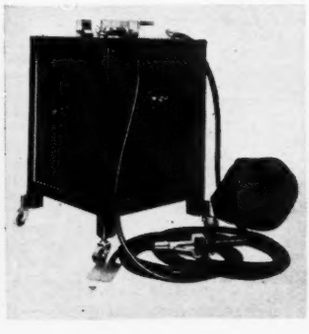
*American District Steam Co., North Tonawanda, N. Y.*

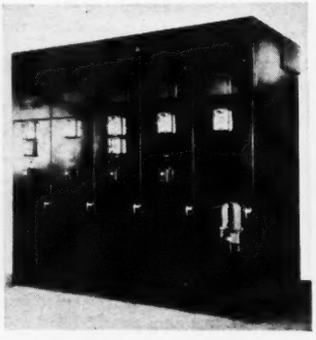
### PROPORTIONING FEEDER

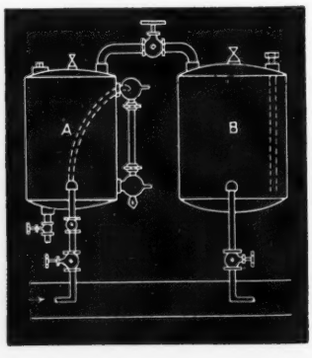
"MODEL B JUNIOR" feeder has sight feed indicator and operates on fluid-piston principle. *A* filled with an inert hydrocarbon colored red; *B* with reagent solution. In response to pressure difference between pitot tubes, proportionate quantity of water rises into *A* and into upper gage fitting, where water drops through oil in glass one drop at a time. Oil is displaced from *A* across a needle valve into *B*, causing reagent to flow into discharge pitot tube. 5-gal. capacity. Also made as 3-tank unit for proportioning two reagents.

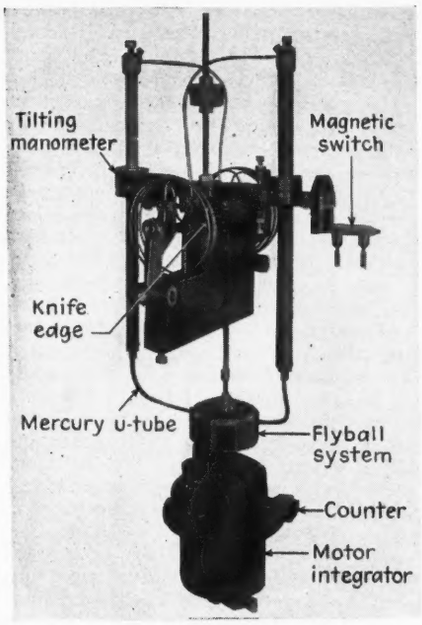
*D. W. Haering & Co., Inc., Chicago.*












### INTEGRATING FLOWMETER

"CENTRIMAX" flowmeter integrates directly by making use of centrifugal force exerted by a flyball governor. A tilting manometer, balanced against integrator centrifugal force, moves as manometer pressure varies and shifts mercury level in *U* tubes. At beam end, magnetic switch closes and opens to govern integrator rotation speed. A totalizing remote counter, geared to integrator, shows revolutions in terms of flow. Records up to 3,000 lb. per sq.in. Catalog N-28.

*Leeds & Northrup Co., 4902 Stenton Ave., Philadelphia, Pa.*

### PORTABLE pH METER

TWO MODELS, one with simple potentiometric circuit and either quinhydrone (for acid determinations) or antimony electrodes (for alkaline determinations), or complete with both sets of electrodes. Other model has vacuum-tube amplified potentiometric circuit with either quinhydrone, antimony, glass electrodes, or all three. Bulletin M-361A.

*Thwing-Albert Instrument Co., 3339-41 Lancaster Ave., Philadelphia, Pa.*

### MULTI-POINTER DRAFT GAGE

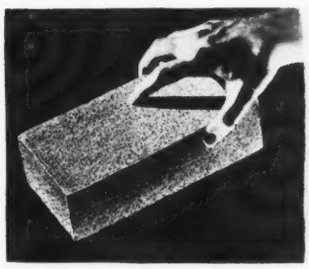
THIS GAGE is a mechanical diaphragm-operated unit consisting of a flat calibrated spring, a sealed link, and a power diaphragm supported by a second link pivoted at one end on calibrated spring, at the other on sealed link. Draft applied to left side of diaphragm causes movement of system to left which is opposed by flat calibrated spring. Motion is transmitted by sealed link and carried by drive link to indicating pointer. For pressure indication, connection is made to right side of diaphragm; for differential pressure, connections are made to both sides of diaphragm. Units of 1 to 12 diaphragms; semi-flush, or full flush-mounted surface.

*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.*

### INSULATING BRICK

"JM-20" for use behind refractory walls and also for direct exposure at temperatures up to 2,000 deg. F. where there is no flame impingement, slag action or mechanical abrasion. A combination of a high-quality refractory clay and a manufactured, fibrous, light-weight, inorganic aggregate. Weighs less than 1.7 lb. per standard 9-in. equivalent. Said to have an unusually low heat capacity, less than ¼ that of ordinary refractories, and a thermal capacity less than 1/6 that of fire brick.

*Johns-Manville Corp., 22 East 40th St., New York, N. Y.*



### UNIVERSAL PILLOW BLOCK *(photo below)*

FOR mounting in any position, this pillow block has two oil reservoirs. Upper one feeds shaft as needed through graphite plugs and pressure-packed channels. Unconsumed oil is diverted through grooves into lower wool-packed reservoir, and is again fed to shaft and bearing through feed plugs. Claimed to operate for long periods on a single oiling, to have a greater bearing area and to operate efficiently at high speed.

*Randall Graphite Products Corp., 609-613 West Lake St., Chicago, Ill.*

### THERMAL OVERLOAD MOTOR SWITCH

FOR fractional-hp. motors, "Thermotector" consists of thermostatic bimetallic helix, heater helix, flat steel spring, and contact arm. When helix is heated above normal, free end rotates and reverses bow of spring. As spring passes dead center, it moves contact arm and disconnects motor. Automatically reconnects after temperature has reached normal again, or may be obtained with manual reset.

*General Electric Co., Schenectady, N. Y.*

### STEAM HOSE

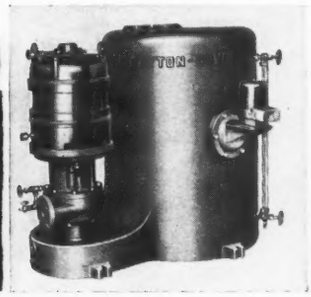
A STEAM- and heat-resisting rubber tube wound with four plies of high-strength asbestos cord alternating in direction; cords rubber-cushioned and -wrapped. ½-, ¾-, 1-, 1¼-, 1½-in. I.D. sizes for 175 to 200 lb. pressure. Maximum length 50 ft.

*U. S. Rubber Products, Inc., 1790 Broadway, New York, N. Y.*

### CONDENSATE-RETURN PUMP AND RECEIVER

BRONZE-FITTED, close-coupled vertical pump is flange-mounted to a vertical cast-iron receiver tank equipped with sylphon float switch gages and tapped opening. Units are self-contained and require no foundation or baseplate. 30-, 50-, or 80-gal. tanks with appropriate pumps.

*Dayton-Dowd Co., Quincy, Ill.*



### AIR-CONDITIONING UNIT

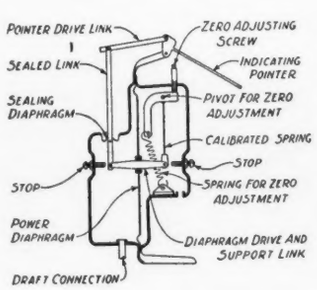
SAID to do a complete air-conditioning job: cooling, dehumidifying, heating, humidifying, cleaning, and air circulation. Available in sizes from 300 to 11,000 cu.ft. per min., in refrigeration capacities from 2 to 50 tons, with or without humidifying and heating elements, and as floor-mounted or ceiling-suspended type. Copper-finned coils, heavy welded-steel casings, quiet fans, self-cleaning hygrostat-controlled spray nozzles.

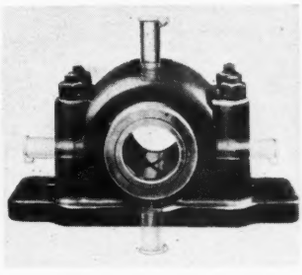
*Carbondale Division, Worthington Pump & Machinery Co., Harrison, N. J.*

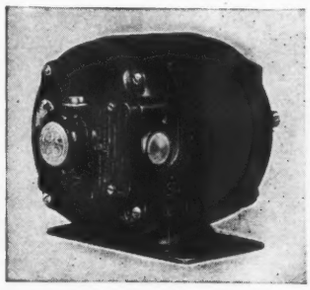
### OIL PURIFIER

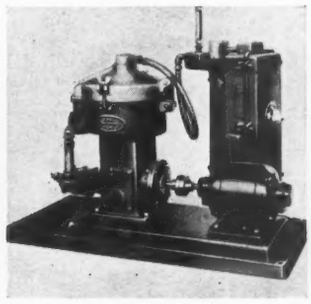
FOR diesel engines, "400 Series" centrifugal "Hydroil" purifier in three sizes for diesels up to 12,000 b.hp., and range of 30 to 100 gal. of lubricating oil per hr. As fuel-oil purifier, has capacities from 50 to 125 gal. per hr. Bulletin No. 502.

*Goulds Pumps, Inc., Seneca Falls, N. Y.*







# A River Goes Wild

**A preliminary report of flood effects and conditions in the Ohio Valley. Detailed data will appear in *Power* for April**

By E. J. TANGERMAN
Managing Editor

CINCINNATI, FEB. 7—Our train feels its way along the Miami River and Mill Creek Valleys, past houses on their sides, debris and rubbish piled all around, a coal silo turned tower of Pisa, tank cars lifted from their trucks, farm outhouses smashed to smithereens. Over everything is a coating of odorous dirty yellow-gray slime. A fountain spouts doggedly in the midst of what was once an amusement park. A dining-car waiter peers big-eyed from the window and says, "What scayuhs me is wheah dat watah wuz!"

We inch into Cincinnati's Union Terminal, and the cab driver pilots me through the rain down debris-covered streets. Driftwood is in trees. The cab driver vows, "I wish it would really rain! Might clear away some of this muck!" As if Cincinnati hasn't had rain enough. I register at the hotel, then am hustled over to get my first "shot" of anti-typhus serum. For three days I am to have a left arm that feels like somebody hit me with a baseball bat.

Along the waterfront, trucks are overturned, houses upset, stoven in, or floated into queer places. Tank trucks pass, spraying heavily chlorinated water, and shopkeepers and householders moodily clear out front rooms with shovel and firehose.

West End plant stands out of piles of debris, apparently almost unscathed, but everywhere water is dripping or being pumped out. I look around, talk to Chief Engineer Rouse, then go back to higher and drier ground.

### System in General

Normally, Cincinnati Gas & Electric Co. has a capacity of 126,000 kw. at Columbia Station, about 20 mi. downriver from the city, and 144,000 kw. at West End Station, a total of 270,000 kw., with a system peak of 250,000 kw. Columbia is now being increased to 191,000 kw., and West End to 179,000. Both, though designed to withstand a flood stage of 72 ft., 1 ft. higher than any previous flood, faced high water of 79.99 ft.

Normal interconnections are established with three other utility systems and two industrial plants, in the first case a "to or from" arrangement, and in the second an absorption of excess generation. The interconnection with Dayton Power & Light Co. is normally 25,000 kva., but was increased to 50,000 kva. during the emergency. The 45,000-kva. interconnection with Louisville Gas & Electric Co. was not available, because their plants were under water as well. This interconnection was re-established Sat., Feb. 6, for sending power to Louisville to help that system restore its load. Two interconnections with Public Service Co. of Indiana include a 5,000-kva., 60,000-volt tie-in to Connersville, Ind. These are covered by firm power contracts for delivery of power from Cincinnati to Pub. Serv. Co. of Indiana. While the Cincinnati plants were out, flow of power was reversed, and Cincinnati received up to 30,000 kw.

Cincinnati Gas & Electric Co. has two normal industrial-plant interconnections at Hamilton, Ohio—one with Champion Coated Paper Co.'s steam plant and the other with Ford Motor Co.'s hydro plant, in each case taking their surplus power. During the emergency, 2,000 to 3,000 kw. came from Champion and 400 to 1,500 from Ford. Both plants do not normally reach the upper figure.

New connections established during the emergency were: City of Hamilton, Ohio, (steam plant) 4,000 to 5,000 kw., in parallel with Cincinnati's system (as were Champion and Ford); City of St. Bernard, Ohio, (steam plant) 200 to 600 kw., taking a detached piece of load; Gardner-Richardson Paper Co., Middletown, Ohio, (steam plant) 1,500 kw. on a detached piece of load; Stearns-Foster Co., Lockland, Ohio, (steam plant adjacent to Cincinnati) 500 kw. on detached load, Allis-Chalmers Co., Norwood, Ohio, (steam plant adjacent to Cincinnati) 450 kw. in parallel.

While not all these interconnections were vitally necessary, they were made to insure service wherever possible, not only to essential services, but also to residential customers in sections where homes or distribution equipment were not under water. State Public Service Commissions in Ohio and Kentucky, municipal bodies, customers, and others have been uniformly highly complimentary regarding speed and sureness of this job and the fine results obtained. Here are examples: During the flood, continued service was maintained to all telephone and telegraph companies, radio broadcasting stations and fire-alarm systems, except where local distribution was affected by high water. Service was also maintained to all hospitals, except one abandoned because of high water. No newspaper issues were delayed because of lack of power. Half of downtown street lights were kept in service. Within 12 hr. after failure of local generating plants, service was restored to drug stores, doctors who had stocks of serum, food-supply businesses, and to water-pumping plants in small communities outside Cincinnati (some of the latter were never disturbed). Downtown Cincinnati, supplied by low-voltage a.c. and d.c. networks, was never de-energized, nor was the Netherland Plaza Hotel, restaurants, drug stores, and other essential business in that area. Special arrangements were made to take care of requests from houses where people were reported sick.

On a gradual basis, starting Monday, Jan. 25, service was restored to residential customers on a limited basis, taking care of 60% of customers by Thursday and 90% by Saturday, Jan. 30. Remaining 10% did not receive service at that time because either their homes or local systems were under water. E. S. Fields, manager, Electrical Department, pointed out to me that the only reason this could be done was through whole-hearted co-operation of customers throughout the city. The entire system, except that part under water, was energized, so that anyone who wanted to could have drawn his normal load, but newspaper and radio appeals were made to shut off electric refrigerators and other electrical units during peak period from 5 to 10 p.m. each night, and to limit residential use of electricity to one light and the radio. Industrial power users also staggered their loads voluntarily, not using power during the peak, and restricting use during other periods.

26,000 meters went under water, 150 poles down, 8 power substations totalling 75,150 kva. out, two railway substations in Kentucky totalling 4,000 kw. out (rotary converters in both were totally submerged), 31 industrial substations totalling 24,338 kva. submerged, 529 single-phase transformers totalling 11,550 kva. submerged, and 198 small 3-phase transformer installations submerged, totalling 14,658 kva.

### West End Station

West End Station was designed for a maximum flood-water level of 1 ft. over the previous greatest flood, in 1884, when water reached 71.1 ft., according to D. S. Brown, manager, Production Dept. But this flood reached a peak of 79.99 ft., as contrasted with 31 ft. on Feb. 7.

When the river began its rise, preparations were made to withstand flood by building wooden bulkheads and sandbagging them around six 10-ft. openings in the basement. Luckily, West End has a

**Fig. 1—The Flood at Cincinnati. Fig. 2—Half the basement at West End.**

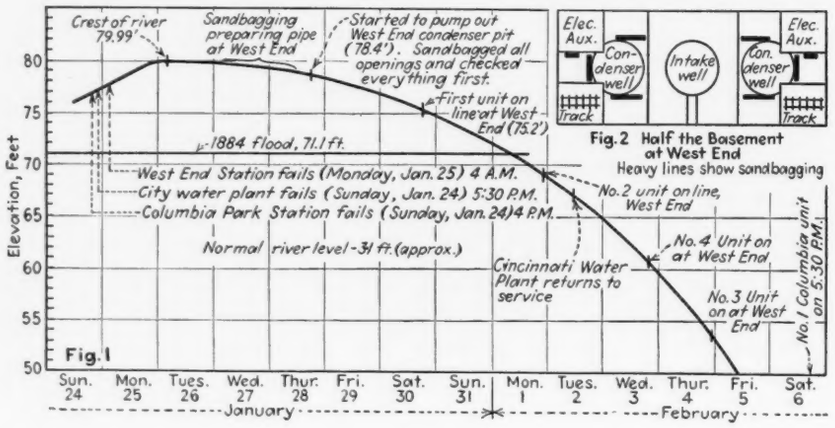






Fig. 2 Half the Basement at West End
Heavy lines show sandbagging

divided basement, so part of it could be allowed to flood, except for condenser walls and electric-auxiliary rooms. Condenser-well walls are 6 ft. thick with a 25-ft. base slab, so no trouble was expected from lifting. But well walls had been pierced at several places to let in conduits leading to pumps, etc., below critical water levels, and it was "rain" through these openings that eventually shut down the plant. This occurred at a level of 78 ft., at 4 a.m., Jan. 25.

Even then, motors did not fail, but the rain shower onto compensators caused several serious "blows," and other equipment was becoming so wet that it was considered inadvisable to keep it operating. Also, electrical auxiliaries, considered far above any normal flood stage, were in simple concrete-walled rooms designed for 300 lb. per sq.ft. Each had a single door which could be sandbagged shut, so they were kept dry until water got up to 11 ft. above their floors. 11 ft. of water, corresponding to about 700 lb. pressure at base of walls, was a source of potential trouble, so water level was allowed to rise to just below electrical equipment. A few hours later, even this had to be abandoned, but essential electrical equipment was salvaged.

Constant and unremitting work permitted No. 1 turbine at West End to be back on the line at 6 p.m., Jan. 30, while flood level was still 75.2 ft. No. 2 went on at 10 p.m., Feb. 1, No. 4 on Feb. 3 at 7:30 p.m., and No. 3 the next day at 11 p.m., only 3 hr. after the street outside was clear of water!

West End dried out its own compensators and other electrical equipment (as did Columbia) and built two temporary substations to carry the load. Feb. 10 these were still in use.

### Columbia Station

Columbia, downriver about 20 miles, had pretty much the same situation as West End—only worse. Its 300x400-ft. basement is all on one level, so they had to hold water out of the entire plant there. Though the plant was designed for only 72 ft. maximum high water, Chief Engineer Joe Heimbrock and his crew kept it operating until water reached 75 ft. at 4 p.m., Sunday, Jan. 24. Water coming into the cribhouse well, containing service pumps, etc., couldn't be kept out, because pumps and equipment had to be attended by an operator, and Mr. Heimbrock felt that it was growing too dangerous to keep a man down there.

The first step in getting back on the line was to start up a boiler to heat and dry out the plant. 500 tons of powdered coal had been put in the bunkers, and though the coal tipple was useless, this was sufficient until arrangements could be made to unload coal at another tipple 5 miles above the plant and to bring it in by truck. The first boiler also supplied steam to pump out condenser wells with pumps and pulsometers. Pumping was begun when basement floors still contained 2 ft. of water.

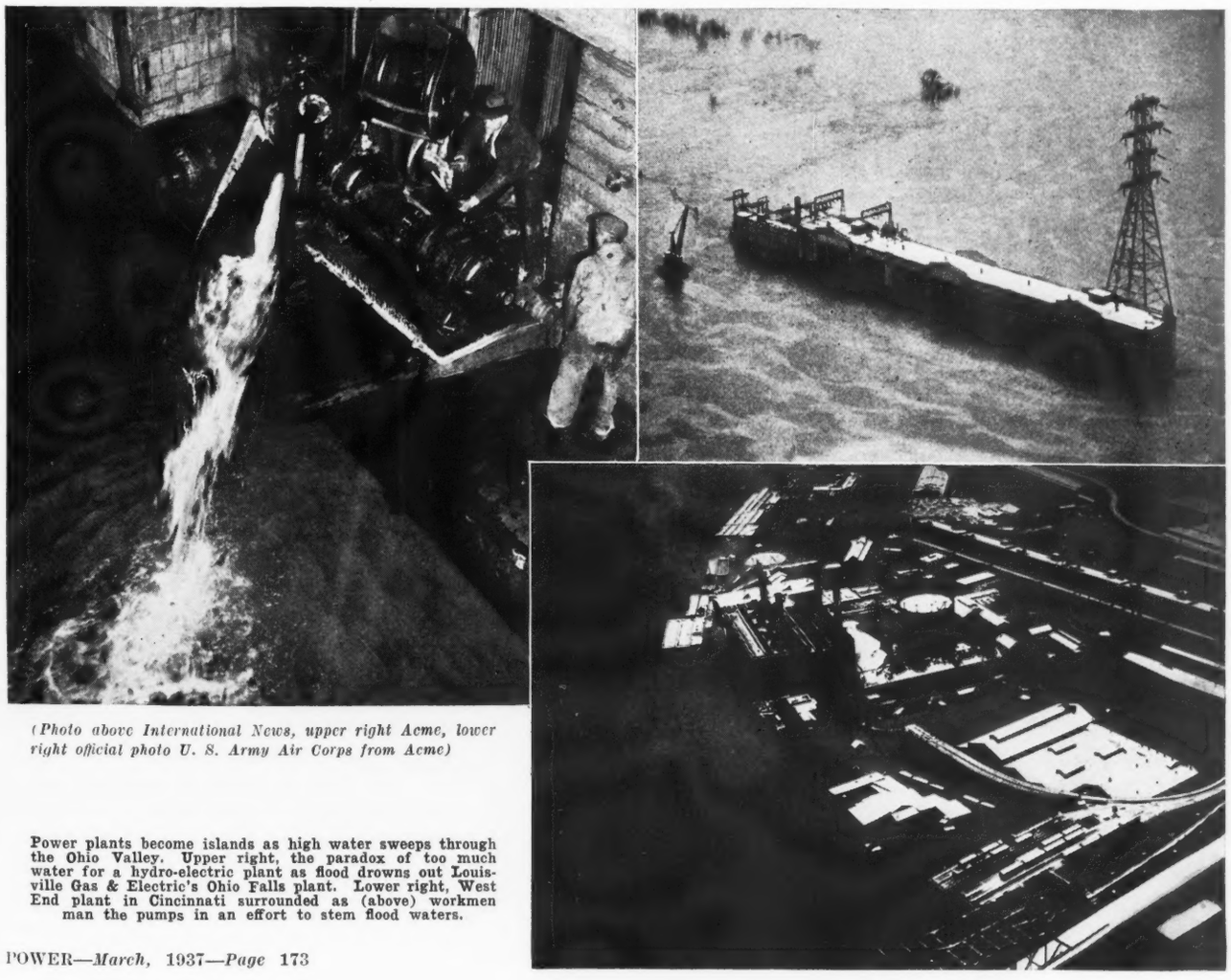
Cincinnati suffered severely from lack of water for 9 days, the city supply failing "Black Sunday," Jan. 24, and not resuming until Feb. 2. Water is drawn from the Ohio River at California, Ohio, about 15 miles above the city proper. Taken through a 7-ft. tunnel 1500 ft. long from an intake pier on the Kentucky shore, it passes to the filtration plant at elevation 100. Thence it passes through a 7-ft. tunnel 22,266 ft. long to the main pumping station on Eastern Ave. Four 8-ft. stroke, vertical triple-expansion engines at the 75-ft. level have long piston rods leading to 30,000,000-gal. per day pumps in a 98-ft. pit 85 ft. deep.

As water rose, sandbagging was done by a crew under direction of C. H. Anderson, in charge of the Supply Division, but this began to fail when water was about 18 in. over the floor. Also, ash tunnels under boilers were flooding, so to avoid probable loss of life of pump operators, the plant was abandoned at 5:30 p.m. This cut out main city water supply.

Water had been stored in tanks removed from tank cars and spotted about the city, and these were replenished throughout the high-water period. When water receded, induced-draft fans, motors and motor-generator sets had to be dried out slowly, so the plant was not returned to service until 11 a.m. Feb. 2. It is now supplying normal 70,000,000 g.p.d.

### Industrial Plants

Industrial plants in Mill Creek Valley had up to 11 ft. of water in their engine rooms. Andrew Jergens Co. had 8 ft., Lunkenheimer's Fairmount plant wet its



*(Photo above International News, upper right Acme, lower right official photo U. S. Army Air Corps from Acme)*

**Power plants become islands as high water sweeps through the Ohio Valley. Upper right, the paradox of too much water for a hydro-electric plant as flood drowns out Louisville Gas & Electric's Ohio Falls plant. Lower right, West End plant in Cincinnati surrounded as (above) workmen man the pumps in an effort to stem flood waters.**

transformers and engines, American Can had 8 ft., King Machine Tool Co. had about 10 ft., Wm. Powell Co. 11 ft. in its engine room, Cincinnati Union Terminal heating plant had 22 in. in the boiler room, with substations and motor-generator set soaked. The latter plant is operating with a diesel locomotive supplying auxiliary power. Chief Hubbell saved 25 motors by lifting them to barrels and boxes in the boiler room.

Other industrial plants, though high and dry, were left without water when the municipal supply failed, so had to close down. Fox Paper Co. had its coal supply tied up. Chief Marx at Heekin Can Co. used seepage for boiler water until the river fell and left his basement dry. Chief Pattullo at R. K. LeBlond Machine Tool Co. has a small lake that served him. Chief Theiler at Cincinnati Chemical Wks. has a well—and pumped water to aid thirsty townsfolk.

### Louisville

LOUISVILLE, FEB. 10—Louisville Gas & Electric Co. has three power plants along the Ohio: Waterside, a 92,500-kw. stoker-fired steam plant; Canal, an 18,500-kw. steam plant; and the 80,000-kw. Ohio Falls hydro plant, a total of 191,000 kw. of capacity. All of this equipment except the upper busses was under water, as was three-quarters of the distribution network, according to A. W. Lee, vice-president in charge of operation. As can be seen from Fig. 3, the flood at Louisville surpassed the 1884 record high of 46.7 ft., and went on to 57.1 at the crest, staying above all previous highs for 12½ days.

Although these plants (except the hydro) were designed to withstand only a 48-ft. river (18 in. above previous high water), they actually did not go out until the river reached 54 ft., a splendid testimony to the efforts of their crews to keep them operating. Had the duration of the flood been shorter, they might have stood it even then, for they stood the highest water on record for 3 days.

### Waterside

At Waterside, the turbine-room elevation is 457 ft. above sea level, but water rose to 460.1 ft. Operators installed semi-permanent wood and sandbag bulkheads at all openings and tried to divert seepage into the ashpit and the three condenser pits in turn, but all filled in the final 12 hr. of plant operation. Also, floors began to bulge in several places and water to flow in sheets through wall cracks that could not be braced. The switch was finally pulled at 11:39 p.m., Sunday, Jan. 24, and the machines went down 5 min. later.

As the river receded, gasoline construction pumps were brought in and used for boiler-feed units, so that steam was up at a river level of 455 ft., 3 days before the river dropped to the 442-ft. level of the boiler-feed pumps.

The hydro plant, a low head installation, went off the line at 421 ft. due to lack of head, and later was flooded, when logs battered in upstream windows, far above generator tops. Canal Station also fought the water as Waterside did, but lost its battle 3 hr. earlier.

Although interconnected power is available, many sections of Louisville are still without lights, because the distribution system is underground. No cable is expected to be lost, but many potheads are wet and 10 out of 13 substations were under 6 in. to 6 ft. Most have been cleaned up. 20,000 to 40,000 electric meters were soaked and 30,000 gas meters.

Interconnections now providing power include: Kentucky Utilities Dix River Station (hydro) and also a general system tie-in, including the steam plant at Pineville, Ky.; Cincinnati Gas & Electric Co., now supplying to Louisville; and Public Service Co. of Indiana at Indianapolis.

### Water Supply

Louisville Water Co., Inc., a municipal utility, has its raw-water or river plant about 4 miles above the center of town on the Ohio. The station is designed with its operating floor 7.4 ft. over the 1884 flood level, but this crest rose 4.5 ft. over the floor. Joseph D. Scholtz, president, and L. S. Vance, principal assistant engineer explained that water covering steam pipes leading from boiler house to engine room finally shut them down Jan. 23 a.m.

However, they immediately hired a river steamboat, which was backed up to the station and connected to the engine through flexible steam hose. With this arrangement, a 24,000,000-gal. per day Allis-Chalmers triple-expansion, crank-and-flywheel unit was started by 6 p.m. the following night, and 1½ hr. later they had water up to their reservoir on Crescent Hill. Service was maintained from then on, except when steam hose blew out and was replaced with pipe (longest outage 4½ hr.). With water 12 or 13 ft. up on its 18-ft. flywheels, this unit operated for 4½ days without oil in its bearings, before a new static-head oiling system was worked out.

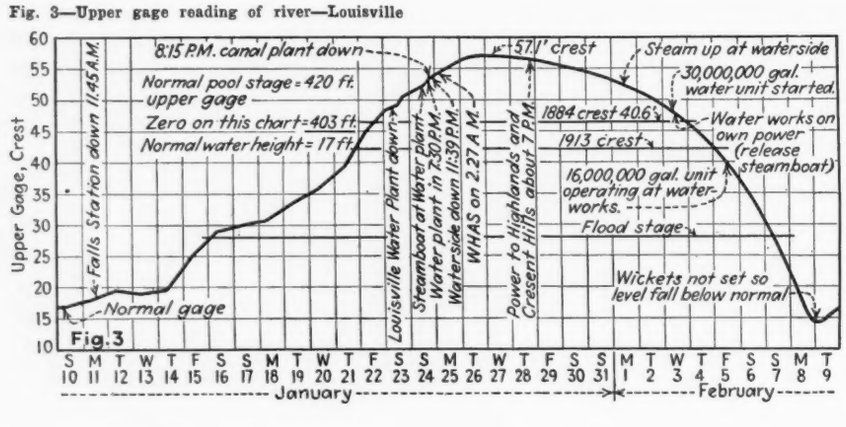
As the water fell, plant boilers were restarted, and the steamboat released Wed. noon, Feb. 3, and in rapid order thereafter, other units were replaced in service. The present problem is to repair the railroad spur so that coal can be brought in.

At the beginning of the emergency, Henry Vogt Machine Co., high above the water, offered its 600-kw., 3-stage turbo-alternator plant to Louisville Gas & Electric Co. The offer was accepted, and Vogt supplied Fenley's Model Dairy, Inc., Grocers' Baking Co., Donaldson Baking Co., Sts. Mary and Elizabeth Hospital and Waverly Hill Tuberculosis Sanatorium, all vitally necessary to citizens of the isolated and beleaguered city. Vogt carried these loads until utility service could be reconnected Feb. 9, a period of 16 days. Frank Fehr Brewing Co., with its own power plant and wells, provided much of the city with drinkable water.

### Other Cities

Portsmouth, Ohio, and Evansville, Ind., power plants also suffered severely. At Vevay, Ind., a town of 1,200 people, the Ohio River is eating away the bank beneath its municipal plant. All equipment has been removed, and the plant is expected to collapse soon. At Greendale, Ind., railway locomotives replaced flooded-out boilers to keep town plants operating.

**Fig. 3—Upper gage reading of river—Louisville**


8:15 P.M. canal plant down
57.1' crest
Steam up at waterside
30,000,000 gal. water unit started.
Normal pool stage = 420 ft. upper gage
Zero on this chart = 403 ft.
Normal water height = 17 ft.
1884 crest 40.6'
1913 crest
Water works on own power (release steamboat)
16,000,000 gal. unit operating at water-works.
Flood stage
Wickets not set so level fall below normal
Normal gage
Fig. 3
Falls Station down 11:45 A.M.
Louisville Water Plant down
Steamboat at Water plant
Water plant in 7:30 P.M.
Waterside down 11:39 P.M.
WHAS on 2.27 A.M.
Power to Highlands and Crescent Hills about 7 P.M.
Upper Gage, Crest
60 55 50 45 40 35 30 25 20 15 10
S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9
January
February

## Contest for Welding Papers

A $200,000 prize award has been established by James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, to be distributed among winners of 446 separate prizes for papers dealing with arc welding as a primary process of manufacture, fabrication or construction in 11 major divisions of industry. Principal prize winners will receive not less than $13,700; other prizes range from $7,500 to $100, the latter sum to be awarded each of 178 contestants who receive no other prize. Entrants may communicate with Foundation Secretary A. F. Davis, P.O. Box 5728, Cleveland, for information on rules and conditions covering awards.

## Resume Construction of Hydroelectric Project in Va.

Engineers on Virginia's Pinnacles of Dan $3,000,000 hydroelectric project, their differences with scenic beauty compromised, are now awaiting readvertisement of bids on tunnel work and awarding of a contract before resuming construction.

Sheridan P. Gorman, acting state PWA director, said that under an agreement reached by PWA, National Park Service, and the city, he believes the wild beauty of the Pinnacles area could be preserved

# MEETINGS

**Smoke Prevention Assn. and Fuel Burning & Air Pollution Exhibition**—*31st Annual Convention, May 31–June 5, Hotel Pennsylvania, New York, N. Y. Frank A. Chambers, secretary-treasurer of S.P.A. and smoke inspector of Chicago, in charge.*

**National Oil Burner & Air Conditioning Exposition & Convention**—*March 15–19, Convention Hall of Commercial Museum, Philadelphia, Pa. Oil Burner Institute, New York, in charge. C. F. Curtin, secretary.*

**Greater New York Safety Council**—*8th Annual Convention, April 13-15, Astor Hotel, New York, N. Y. John Stilwell, vice-president, in charge.*

**American Ceramic Society**—*Annual Meeting, March 21-27, New York, N. Y. Ross C. Purdy, Secretary, 2525 North High St., Columbus, Ohio.*

**A.S.M.E.**—*Semi-Annual Meeting, May 17-21, Hotel Statler, Detroit, Mich. Sabin Crocker, Secretary Detroit Committee, in charge.*

largely with use of proper care. The project borders on the Skyline Drive route to the Great Smokies. Gorman said that changes in pipe-line plans ran some costs over expectations and that a $92,045 conservation fund "may be required to properly protect the area between Pinnacle Spur and the Penstock, commonly referred to as the 'bowl area'".

### Electricity from Refuse in N. Y.

Over 750 tons of garbage are being incinerated daily in New York City's garbage-burning electric plant, put into operation in early February. The new $1,500,000 plant, part of a $4,000,000 city-wide garbage disposal scheme, includes two boilers, each of about 5000-sq. ft. capacity. Some of the electricity produced will be used to heat light and operate the municipal garage, part for charging batteries of electric sanitary trucks, and surplus, it is said, will be sold to Consolidated Edison Co.

### Johns Hopkins Celebrates 25th Engineering Anniversary

The School of Engineering of the Johns Hopkins University, Baltimore, Md., observed the 25th anniversary of its founding in a 3-day program which began Feb. 19. Features of the celebration were the extensive exhibition of materials and processes relating to current engineering research problems and the address delivered by Dr. Karl T. Compton, M.I.T. president, at the University's 61st Commemoration Day exercises Feb. 22.

Exhibitions and demonstrations included special methods of investigating the properties of high voltage cable. This portion of the display was a natural outgrowth of research carried on for many years by Dr. J. B. Whitehead, first professor of electrical engineering and now dean of the School, who read a paper on "Limitations of High Voltage Insulation".

High-frequency voltage, as "man-made lightning", was generated to show effect of lightning upon modern power transmission lines. Professor A. G. Christie, widely known consultant on power-plant construction, discussed related problems during the conference period.

Other exhibits dealt with recent developments in air conditioning, oil heating, steam-vapor jet refrigeration, pure-fluid lubrication, automotive diesel power, pumping, and magnetic tests of welds. Technical papers read by Prof. W. B. Kouwenhoven, W. J. Huff and J. T. Thompson dealt respectively with electrical accidents, gas engineering research at Johns Hopkins, and motor vehicle taxation. Prof. J. H. Gregory's paper on water purification was read posthumously.

### Dr. Jacobus Honored On 75th Birthday

Dr. D. S. Jacobus, supervising engineer of Babcock & Wilcox Co., celebrated his 75th birthday on Jan. 20. Engineers joined in honoring Dr. Jacobus at a birthday dinner held at the Engineers' Club in New York City on Jan. 29. Members of the Boiler Code Committee, the A.S.M.E., arranged the dinner.

## OBITUARIES

WILLIAM C. GOULD, 56, chief engineer of Beth Israel Hospital in Boston, Mass., died in that hospital Jan. 4.

EDWARD BARNARD MEYER, 54, chief engineer of electric engineering department of Public Service Electric & Gas Co. of Newark, N. J., died Jan. 30 at his home in Newark after a month's illness. Mr. Meyer served as president of the A.I.E.E. from 1935 to 1936, and was author of many papers on electric transmission and distribution problems.

WILLIAM P. BOWMAN, manager of John A. Roebling's Sons Co.'s New York branch, died Jan. 22.

WALTER A. CROWELL, 55, operator of Public Service Co. power station on Brook St., Manchester, N. H., since 1911, died in a Nashua hospital Jan. 6.

WILLIS LAWRENCE, 69, superintendent of motive power for Interborough Rapid Transit Co., New York, died Jan. 9 of a heart attack. Mr. Lawrence has been

responsible for the past 20 years for operation and maintenance of all power houses in the Interborough system of subway and elevated lines and for four New York Railway power stations, which furnish energy for surface cars.

ALFRED WILSON FULLER, 89, a leader in developing Goodrich Falls Electric Light Co., and Bethlehem Electric Light Co., died Jan. 5 in Gorham, N. H.

JOHN R. AIKMAN, 59, assistant to general manager of the Winnipeg, Man., hydroelectric system died recently in his office from a paralytic stroke. Mr. Aikman had been with Winnipeg's system since 1911.

LAURENCE C. HOUGH, 40, New England sales representative for Pitometer Co., New York, N. Y., died suddenly of heart failure in Savannah, Ga., Jan. 13.

## PERSONALS

GERALD R. BROPHY has been appointed to the development and research staff, International Nickel Co., Inc., at Bayonne, N. J.

WILLIAM H. LAWRENCE, chief operating engineer of New York Edison Co., retired Feb. 1, after 47 years of service.

T. D. MONTGOMERY has been made manager of Foreign Sales Division, Cutler-Hammer, Inc., Milwaukee, Wis.

HEINRICH SCHNEIDER, formerly assistant vice-president of American Locomotive Co., Auburn, N. Y., has joined Hooven, Owens, Rentschler Co., Hamilton, Ohio as vice-president in charge of diesel engineering. A native of Switzerland, Mr. Schneider has had a notable career both in Europe and America and is well known to engineers for his hydro-differential transmission. With American Locomotive, he was in charge of diesel engineering, and just recently completed a reorganization of that department.

C. M. HOUCK, formerly manager of inspection, Pittsburgh Testing Laboratory, has been elected vice-president to succeed A. R. Ellis, recently named president.

T. A. MARSH, central division engineer of Iron Fireman Mfg. Co., has been appointed chairman, Executive Committee, Fuels Division, A.S.M.E.

JAMES M. GUY, formerly assistant chief engineer, has been promoted to chief engineer of Erie City Iron Wks., Erie, Pa.

JOHN H. PARDEE, former president of Utility Management Corp., New York, N. Y., has been elected chairman of the board. Ralph D. Jennison, formerly vice-president, succeeds Mr. Pardee as president.

LESLIE L. ANDRUS, for two years assistant sales manager of American Foundry Equipment Co., Mishawaka, Ind., has been appointed general manager in charge of sales, service and advertising.

J. C. FAULKNER, assistant chief operator of New York Edison Co., has been appointed assistant operating superintendent of Brooklyn Edison Co. He was formerly associated with Brooklyn Edison in 1926 as Hudson Ave. station superintendent.

## BUSINESS ITEMS

JOHNS-MANVILLE, New York, N. Y., has announced promotion of four officials to executive posts following resignation of E. M. Voorhees, secretary and treasurer, to accept a position as a director of U. S. Steel Corp. Charles H. Roberts has been promoted from general auditor to comptroller, Arthur Olsen to treasurer, Vandiver Brown from assistant secretary to secretary, and W. I. Waite has been made secretary of the officers' board.

AURORA PUMP CO., Aurora, Ill., is now headed by Frank S. Main, president, and Lionel W. Claypool, vice-president, both formerly associated with Westco Pump Division of Micro-Westco.

LINCOLN ELECTRIC Co., Cleveland, Ohio, has appointed William F. Fischer to the sales staff of its Los Angeles office.

LINK-BELT Co., Chicago, Ill., recently appointed Erwin A. Wendell district sales manager at St. Louis, Mo., to succeed Howard L. Purdon, who has been transferred to Chicago sales staff.

JAMES P. MARSH CORP., Chicago, Ill., has appointed Harry A. Pillen regional representative for Cincinnati, Ohio, with offices at 622 Broadway.

ARTHUR D. LITTLE, INC., Cambridge, Mass., is being represented in New York area by Julian M. Avery, 420 Lexington Ave.

LINCOLN ELECTRIC Co., Cleveland, Ohio, has appointed W. R. Smith to sales staff of its Los Angeles, Calif., office.

H. M. BYLLESBY & Co., Chicago, Ill., elected E. M. Newlin of Philadelphia and R. M. Warner of Chicago vice-presidents and appointed Guy Hoffer western division sales manager.

NEW YORK BELTING & PACKING Co., Passaic, N. J., has appointed Charles B. Scott Co., Scranton, Pa., distributor for Scranton district.

COMBUSTION ENGRG. Co., New York, N. Y., will handle sales, engineering and servicing of "Elesco" superheaters and economizers for stationary-plant installation. Manufacture and inspection will be handled, as before, at Superheater Co.'s East Chicago, Ind., works.

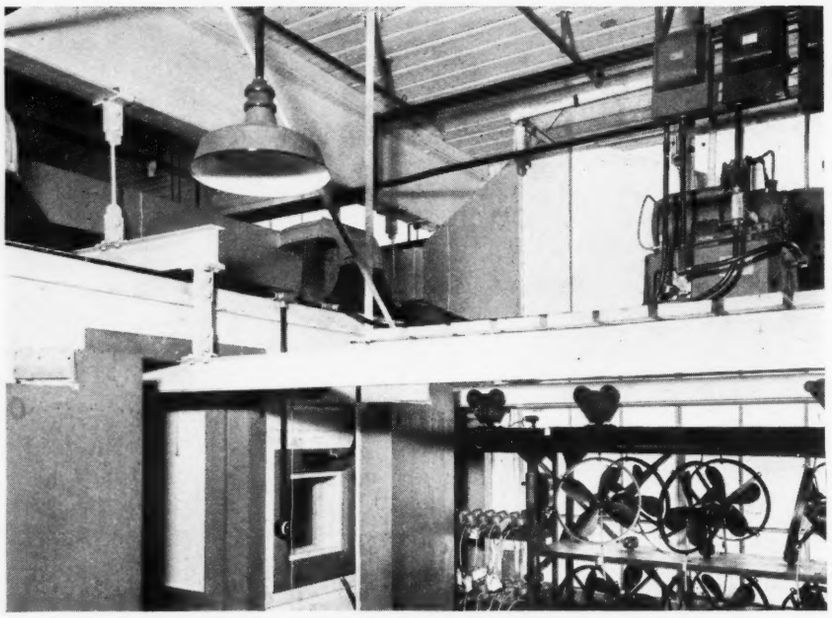
ROLLER-SMITH Co., New York, N. Y., has appointed H. A. Stanley district sales agent in North and South Carolina, with headquarters at Charlotte, N. C.

PUBLIC UTILITY ENGINEERING & SERVICE CORP., Chicago, Ill., announces the following apopintments and changes in titles: E. D. Uhlendorf, executive engineer; F. H. Lane, manager, engineering division; A. H. Kuhn, manager, valuation division; G. E. Potter, assistant to executive engineer; W. B. Rittenhouse, assistant to manager, engineering division; W. C. Drummond, power production engineer; H. W. Eales, chief electrical engineer; H. S. Whiton, chief mechanical engineer; H. G. Robey, chief hydraulic engineer; L. J. Willien, chief gas engineer; W. J. Welch, chief design engineer; Stephen Wehner, hydraulic engineer; D. C. Hormell, mechanical engineer; H. O. Matthews, automotive engineer; and J. A Agee, budget control engineer.

WHEELCO INSTRUMENTS Co., Chicago, Ill., has opened an office at 6432 Cass Ave., Detroit, Mich., with James A. Harrison as manager.

NEW YORK BELTING & PACKING Co., Passaic, N. J., has appointed R. B. Moore distributor at Bolivar, N. Y., with branch office at Bradford, Pa.; J. R. Webster sales manager for its South Atlantic district with headquarters at Atlanta, Ga.; Robert W. Crane representative in Buffalo, N. Y.; and Edward M. Powell, former chief clerk of the Chicago warehouse, a member of its sales force in the Chicago district.

COLE-SULLIVAN ENGINEERING Co., 1316 Third St. N., Minneapolis, Minn., is a recently formed merger of Cole Combustion Service Co. of that city, and the Draft Control Division of Sullivan Valve and Enginering Co., Butte, Mont.



**AIR-CONDITIONED TESTING**

Mounted overhead, a hermetically sealed condensing unit supplies cooling for Westinghouse's test rooms at East Springfield, Mass. A sound-proofed duct system with flexible canvas connectors distributes conditioned air to the test rooms

AUTOVENT FAN & BLOWER Co., Chicago, Ill., announces the promotion of Tom Brown to vice-president and general manager and of George J. Kalwitz to general sales manager. Also appointed were seven new representatives: Frank B. Nimmo, Minneapolis, Minn.; R. J. Engel, Appleton, Wis.; Industrial Representatives, Peoria, Ill.; Allan T. Shepherd, Richmond, Va.; Enginering Sales & Service Corp., Louisville, Ky.; and Harold M. Hudson, Seattle, Wash.

MANHATTAN RUBBER MFG. DIVISION OF RAYBESTOS MANHATTAN, INC., is opening a West Coast branch office and warehouse at 778 Brannan St., San Francisco, Calif. A. R. Bradshaw will be manager.

## SCHOOLS and SOCIETIES

EXTENSION DIVISION, Rutgers University, New Brunswick, N. J., has revised its home-study course on air conditioning. Originally prepared in compliance with a demand from utility companies, both electric and gas, the course was organized with heating and ventilating concerns in mind as well as those manufacturing air-conditioning equipment. The revision was made to keep pace with new applications and changes in typical equipment, apparatus, and control devices.

CHARLES E. MCQUIGG, since 1934 director of research for Union Carbide and Carbon Co., in Long Island City, N. Y., will become dean of Ohio State University's college of engineering July 1. In his selection, Ohio State has recalled one of its own alumni to the campus, as Mr. McQuigg graduated in 1909 with a degree of engineer of mines. Dean Embury A. Hitchcock retired as head of Ohio State's engineering college last summer. Since that time, the college has been administered by William O. Turnbull as acting dean.

A.S.H.V.E.'s new technical subcommittee on "Treatment of Air with Electricity" recently held its first meeting of the society's headquarters in New York, N. Y., to map out a research program to discover means of duplicating in indoor conditioned air "certain intangible qualities which seem to be present in outdoor air giving it a particular zest and life." Discussion at the first meeting involved ozonization, ionization and treatment of air with ultra violet rays which has shown interesting possibilities in killing air-borne disease germs.

AMERICAN MANAGEMENT ASSOCIATION held a conference on industrial relations Feb. 9-11 at the Benjamin Franklin Hotel in Philadelphia. The conference, conducted largely on an open forum basis, included discussions on technique of wage negotiation, employer-employee contacts, economic outlook for labor relations, and practical management attitudes toward industrial relations.

W. L. Batt, president of SKF Industries, Inc.; M. Albert Linton, president of Provident Mutual Life Insurance Co.; Alvin E. Dodd, president of American Management Association; Edgar J. Kaufman, president of Kaufman Department Stores, Inc.; and Virgil Jordan, president of National Industrial Conference Board, spoke at the conference.

ARMOUR INSTITUTE OF TECHNOLOGY, Chicago, Ill., is undertaking a series of management engineering conferences to supplement its regular research and educational program. For this year, conferences will be devoted to plant engineering and maintenance, and will consist of informal dinner meetings held weekly at LaSalle Hotel in Chicago, beginning Jan. 15, and ending April 30. Henry P. Dutton, professor of Industrial Management at the Institute, is supervising the series.

# STRAWS

**Pointing the way business winds blow**

St. Joe Paper Co. has contracted James E. Stewart & Co., New York, N. Y., for a $6,800,000 pine-pulp mill at Port St. Joe, Fla., first part of a $20,000,000 development project.

M. H. Renken Dairy Co., 584 Myrtle Ave., Brooklyn, N. Y., has purchased a diesel plant consisting of two 500-hp., 360-r.p.m. diesel engines driving 335-kw. generators. Engines will have exhaust-gas-driven Buechi super-chargers and will burn Bunker C (No. 6) oil. Plant will be installed in near future.

Carrier Corp., Newark, N. J., is completing refrigeration equipment for what is reported world's largest air-conditioning system in J. L. Hudson department store, Detroit, Mich. Giant refrigerating machines requiring 5,000 hp. to drive them, will serve more than 1,200,000 sq.ft. of floor space.

Independent Ice Co., 315 North Holliday St., Baltimore, Md., contracted Clarke Construction Co., American Trust Bldg., for extensions and improvements in ice-manufacturing plant at 315-19 North Holliday St. Cost close to $30,000.

New Haven Pulp & Board Co., East St., New Haven, Conn., plans addition to steam-electric plant at local mill, to include boilers, stokers, turbo-generator units and auxiliaries. Cost about $250,000. Boilers furnished by Bigelow Co., New Haven. Awards for other equipment will be placed soon. Frederick L. Smith, 21 East 40th Street, New York, N. Y., architect and engineer.

Godfrey L. Cabot, Inc., 77 Franklin St., Boston, Mass., has selected site in Wicket, Tex., for carbon-black plant with compressor stations to handle about 20,000,000 cu. ft. of residue natural gas per day, including welded-steel pipelines. Cost close to $200,000.

Construction Service, Veterans' Administration, Washington, D. C., receives bids until March 23 for hospital building No. 110 at Kecoughtan, Va., including refrigerating plant, electric elevators, air-conditioning system, complete electrical work, water system and equipment.

Ipswich, Mass., contracted Fairbanks, Morse & Co., Chicago, Ill., for engine-generator unit in municipal electric plant. Cost about $60,000.

Eastern State Farmers' Exchange, 666 Summer St., Boston, Mass., plans boiler plant at new chemical fertilizer works at Cambridge, Mass., comprising several units totaling about 100,000 sq.ft. floor space. Cost over $450,000. A. E. Baxter Engineering Co., 344 Delaware Ave., Buffalo, N. Y., consulting engineer, will take bids soon on general contract.

Procurement Division, Treasury Department, Washington, D. C., plans central-heating plant at new federal prison at Sandstone, Minn. Bids will be asked soon on general contract, covering group of buildings totaling 300x353 ft. Estimated cost about $600,000.

Vince Realty Corp., 250 West 57th St., New York, N. Y., has filed plans for 1-story ice-manufacturing plant, 50x171 ft. Cost over $65,000. David Kaufman, 153 Centre St., engineer.

Coal Valley Hospital, Montgomery, W. Va., Dr. William R. Laird in charge, plans steam power house. Bids will be asked soon. Entire project will cost about $300,000. Warne, Tucker & Silling, Inc., Masonic Temple Bldg., Charleston, W. Va., is architect.

Consolidated Coal Co., Portsmouth, N. H., John C. Shaw, local manager, plans to build a new boiler plant with automatic screening facilities and railroad-car handling, to cost approximately $100,000.

State Tuberculosis Sanatorium, Glencliff, N. H., Dr. R. Deming, superintendent, recommended in its annual report purchase of two 2000-sq.ft., h.r.t. boilers, multiple rotary stokers, and two boiler-feed pumps.

## SOUTH

Charleston, W. Va., plans central-heating plant in new municipal auditorium building, 185x220 ft., to accommodate 5,000 persons. Cost about $430,000. A. F. Wysong, Union Bldg., Charleston, architect, will ask bids on general contract in March.

Meridian, Miss., plans municipal cold storage and refrigerating plant. Cost about $150,000. Financing through Federal aid.

Board of Trustees, Clinch Valley Clinic Hospital, Richlands, Va., plans central-heating plant at new hospital unit. Cost about $200,000. Work will begin early in spring. Hassel T. Hicks, McDowell County National Bank Bldg., Welch, W. Va., architect.

Plaquemine, La., is planning municipal natural-gas distribution system. Bids soon. L. J. Voorhies, Plaquemine, consulting engineer.

Richmond, Va., plans improvements in municipal waterworks, including new pumping and control stations, and development of new source of supply from Cowpasture River. Cost about $8,000,000. Financing through Federal aid. Department of Public Utilities, in charge.

Chesapeake-Camp Corporation, Franklin, Va., recently organized by officials of Camp Mfg. Co., with local lumber mill, and Chesapeake Corporation, West Point, Va., manufacturer of kraft pulp and paper products, plans steam power plant for new paperboard mill. Entire project will cost approximately $3,000,000. General contract has been let to Rust Engineering Co., Clark Bldg., Pittsburgh, Pa. J. E. Sirrine & Co., 215 South Main St., Greenville, S. C., are supervising engineers.

Sewerage and Water Board, New Orleans, La., plans early construction of pumping station for auxiliary service near present municipal water purification works on Carrollton Ave., with two main motor-driven pumping units at rated capacity of 50,000,000 gals. per day. Cost about $215,000.

Federal Power Commission is holding a hearing for a preliminary permit for a proposed power house and equipment to utilize surplus water power from U. S. Dam No. 2 on the Coosa River in Calhoun and Clair Counties, Ala. William Gray Meharg, Anniston, Ala., has made application, which has been protested.

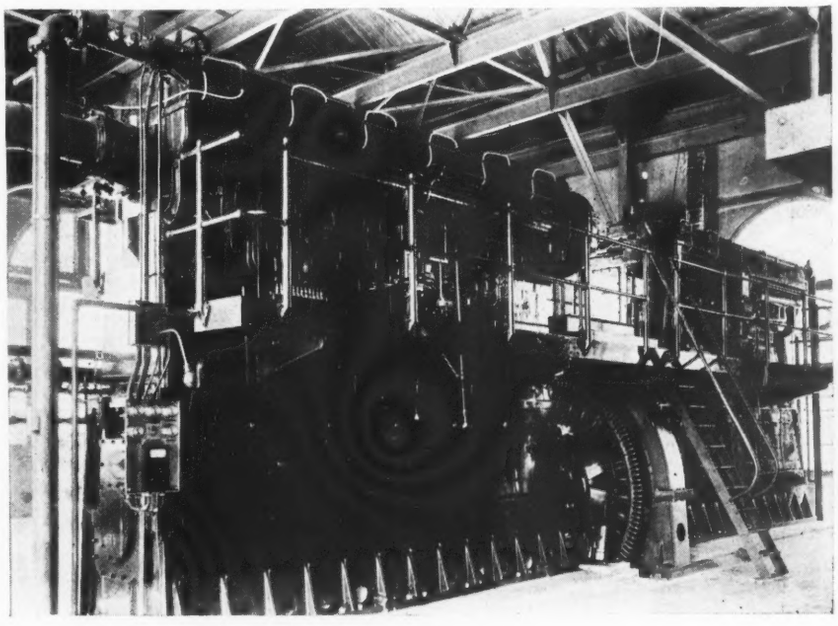
Jonesville, La., will begin work soon on addition to municipal electric plant, to include diesel set and auxiliary, deep-well turbine pumping unit and accessories. Cost over $80,000.

Board of Education, Greenville, S. C., plans boiler plant in new multi-story high school on Vardry St. Bids will be asked on general contract in March. Cost about $400,000. J. E. Sirrine & Co., 215 South Main St., Greenville, architects and engineers.

Georgia Packing Co., Thomasville. Ga., plans steam power plant for processing and other service at new local packing house. Project will cost over $500,000.

## POWERFUL TWINS

Twin 6-cyl., 19½ x 28-in., Ingersoll-Rand diesel engine rated 2,250 hp. at 340 r.p.m. at San Antonio (Texas) Portland Cement Co.



## SOUTHWEST

D. D. Oil Co., Mission, Tex., F. D. Davenport, has surveys under way for welded-steel oil line and booster stations from present system to terminal plants at Brownsville and Port Isabel, Tex. Cost over $150,000.

Ponca City, Okla., has contracted Nordberg Co., Milwaukee, Wis., for engine-generator unit and accessories for munciipal power station at cost of $132,000. Burns & McDonnell Engineering Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

Berry Asphalt Co., Waterloo, Ark., plans 8-in. welded-steel oil line from Troy, Nevada County, Ark., to refining plant at Waterloo. Surveys are under way. Cost over $75,000.

Board of Commissioners, Reeves County, Pecos, Tex., plans central heating plant in new 3-story county courthouse. Bids will be asked on general contract in April. Cost about $125,000. Trost & Trost, El Paso National Bank Bldg., El Paso, Tex., architects and engineers.

Ward Ice Industries, Inc., Fort Smith, Ark., has acquired ice-manufacturing plant of Siloam Springs Ice Co., Siloam Springs, Ark., and will operate as branch plant in future. Extensions and improvements to be made, including new equipment.

Tulsa, Okla., plans installation of motor-driven pumping machinery and auxiliary equipment at Mohawk station, with capacity of 20,000,000 gal. per day in connection with general improvements. Cost about $325,000. W. F. Graham, water commissioner.

Stanolind Pipe Line Co. has awarded a contract to Williams Brothers Corp. for a Lindewelded 20-mile, 8-in. oil line from Webster Station to Texas City, Tex.

Cities Service Gas Co. is building a Lindewelded, 7-mile, 8-in. gas line near Cushing, Okla., from reconditioned pipe.

Mid-Continent Petroleum Co., Tulsa, Okla., contracted Sheehan Construction Co., Daniels Bldg., Tulsa, Okla., for a 48-mile 6-in. welded steel pipeline from oil field area at Pittstown, near Ada, Okla., to Cromwell, Okla., for oil transmission. Cost about $350,000, including booster pumping stations.

Byrd-Frost, Inc., 1611 Holloywood St., Dallas, Tex., D. Harold Byrd, president, will make surveys soon for welded steel pipelines in oil field district at Talco, Tex., for crude-oil transmission. Cost over $1,000,000.

## MIDWEST

Gas Transportation Co. of Michigan, Inc., Mount Pleasant, Mich., and Gas Corp. of Michigan, plan new 4-in. welded-steel pipe line from gas field in Winfield Township, Montcalm County, to Belding and Greenville, Mich.

A. L. Roberts Hotel Co., Winona, Minn., plans central-heating plant in new local 5-story hotel at 5th and Main Sts. Bids will be asked early in the spring. Cost about $350,000. Ellerbe & Co., Minnesota Bldg., St. Paul, Minn., architects; Boyum, Schubert & Sorenson, Winona, associate architects.

Bloomfield, Neb., contracted Fairbanks, Morse & Co., Chicago, Ill., for 150-hp. diesel-engine-generator unit and accessory equipment, for municipal electric plant.

Minden, Neb., will place contract soon for 500-kw. oil-engine-driven generator unit and auxiliaries for municipal plant. Cost about $50,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

Panhandle Eastern Pipe Line Co., 101 West 11th St., Kansas City, Mo., is considering welded-steel pipe line and booster stations from terminus in Indiana to Northwestern Ohio. Cost over $500,000.

Nelsonville, Ohio, will award contracts soon for engine-generator unit, 3 boilers, feed pumps, water treatment equipment and auxiliaries for municipal electric plant. Fund of $80,000 has been arranged. B. M. Coakley, Nelsonville, architect; R. G. Ingelson, 299 South Front St., Columbus, Ohio, consulting engineer.

George W. Deegan, 5510 North Sheridan Rd., Chicago, Ill., and associates plan in Kansas City, Mo., steam power house in connection with main four-story brewhouse, 100x155 ft., other operating units. Cost close to $500,000. A company will be organized to construct and operate plant.

Cedar Falls, Iowa, contracted General Electric Co. for turbo-generator unit and accessories at $56,950, for municipal electric plant; also, for air cooler and switchboard. Westinghouse Electric & Mfg. Co. has secured award for surface condenser at $11,189.

State Budget Committee, Capitol Bldg., Indianapolis, Ind., Edward P. Brennan, director, is considering an appropriation of $2,500,000 for new 12-story State office building. Will include central heating service, electric station for light and power distribution, pumping station, and an air-conditioning system. State architect in charge.

Burroughs Adding Machine Co., 6071 Second Blvd., Detroit, Mich., will build a multi-unit power house for new plant Plymouth, Mich. Cost over $700,000. Albert Kahn, Inc., New Center Bldg., Detroit, architect and engineer.

Garnett, Kan., plans municipal power plant, using 1,000-hp. diesel generator and auxiliary equipment. Bids will be asked soon. Financing through Federal aid. Paulette & Wilson, Federal Reserve Bldg., Topeka, Kan., consulting engineers.

Green Bay Soap Co., Green Bay, Wis., is planning soap and rendering plant, and will need two boilers of about 1500-sq.ft. capacity, stokers, generating unit, and auxiliaries.

Port Clinton, Ohio, is completing plans for municipal electric plant. Cost about $200,000. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

Barnesville Booster Club, Barnesville, Minn., heads project to construct and operate a municipal electric plant, using diesel-engine-generating units. Estimates of cost soon. W. E. Ebling, mayor.

Board of Curators, Missouri University, Columbia, Mo., plans extensions in steam power plant at institution. Also for similar work with steam-distribution system on White Campus, and for extensions in water and electrical utilities. Work in connection with general expansion program to cost about $275,000. Leslie A. Cowan, secretary.

Department of Public Works, Milwaukee, Wis., contracted Dracco Corp., Cleveland, Ohio, for pneumatic conveying equipment for water purification works at $39,646.

Roseau, Minn., plans new equipment at municipal electric plant. Will secure estimates of cost soon. R. J. Hagen, village clerk.

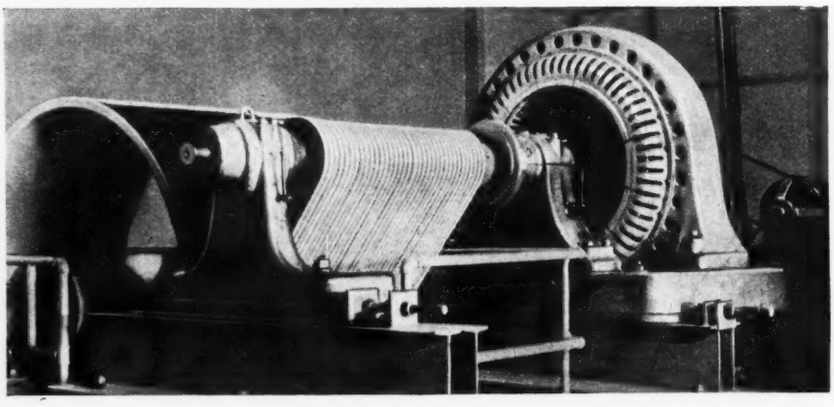
Rock Falls, Ill., is considering new municipal electric plant and will make surveys and estimates. S. H. Feigley, mayor, is active in project.

Niles, Mich., plans large pumping plant for municipal sewage disposal works. Entire project will cost about $400,000, of which $203,000 through Federal grant.

Aetna Paper Co., Dayton, Ohio, contracted Westinghouse for 1,250-kw. turbo-generator and 2,000-sq.ft. condenser. New switchboard and other equipment will be installed. Walter I. Barrows, Reibold Bldg., consulting engineer.

### V-35 BELT DRIVE

How big can a multiple-V drive belt be? This one, although not the final word, packs a lot of power in connecting a reclaimed generator to a diesel-engine-driven line shaft. The drive, composed of 35 Allis-Chalmers Texropes, transmits 328 hp. and steps up speed from 90 r.p.m. for line shaft to 600 for generator motor



WATER DEPARTMENT, Kansas City, Mo., T. D. Samuel, Jr., City Hall, chief engineer, will take bids soon for motor-driven pumping unit and auxiliaries for waterworks pumping station on Nicholson St.

ONAWA, IOWA, has work under way on municipal electric plant, including two 625-hp. Alco diesel units, will cost about $130,000. Buell & Winter Eng. Co., Insurance Exchange Bldg., Sioux City, Iowa, consulting engineer.

FAYETTE, Mo., will enlarge electric plant. Contract has been awarded Fairbanks-Morse Co., Chicago, Ill., for new diesel unit with auxiliaries, at $48,000.

STATE BUILDING COMMISSION, Jefferson City, Mo., Edgar M. Eagan, executive secretary, contracted C. H. Schroeder Building & Construction Co., 2806 North Grand St., St. Louis, Mo., for improvements in power plant at State Hospital No. 4, Farmington, Mo., at $57,088. Entire project with equipment will cost about $280,000. Charles A. Haskins, Finance Bldg,. Kansas City, Mo., supervising engineer.

FOREST CITY, IOWA, has approved plans for municipal electric plant and will begin erection soon. Will include three diesel units totalling 975 hp., oil tanks, cooling tower, switchboard, instruments, etc. Cost close to $170,000. Young & Stanley, Inc., Muscatine, Iowa, consulting engineers.

BEAVER-SAPPA PUBLIC POWER & IRRIGATION DISTRICT, Stamford, Neb., recently organized, plans hydro-electric plant to use water from Sappa and Beaver Creeks in Furnas County, where two dams will be constructed. A transmission line will be built for power service to neighboring districts, including power supply for operation of a series of pumping plants at different points in irrigated area. Cost about $2,000,000. Financing through Federal aid.

MINERS ICE & FUEL CO., Tenth and Kentucky Sts., Joplin, Mo., has approved plans for remodeling ice-manufacturing and cold-storage plant. Cost about $50,000. A. J. Richardson, Miners' Bank Bldg., architect.

CLEVELAND, OHIO, has purchased three Stowe stokers from Johnston & Jennings Co. for its municipal light plant.

INDIANA VENEER & PANEL CO., New Albany, Ind., will include power house in rebuilding of veneer mill, recently destroyed by fire. Reconstruction will cost about $100,000. S. E. Stout is president.

SABETHA, KAN., plans enlarging municipal power plant, including diesel and auxiliaries, with switchboard and instruments. Cost about $50,000. Paulette & Wilson, National Reserve Bldg., Topeka, Kan., consulting engineers.

## WEST

NEW METHOD LAUNDRY CO., Vallejo, Calif., plans steam power house at new laundry on Tennessee St. Cost about $45,000. W. G. Foster, head.

SANTA CRUZ OIL CO., 311 California Ave., San Francisco, Calif., plans boiler plant at vegetable-oil refinery in Alameda, Calif. Cost about $400,000.

DELTA, COLO., contracted Fairbanks, Morse & Co., Chicago, Ill., for one 300-hp., and two 225-hp., diesel-engine-generator units and auxiliary equipment for

## DAM GENERATOR

**One of Boulder Dam's two huge generators, rated 82,500 kva. at 16,500 volts, 60 cycles. The generators will normally operate in parallel and connect to a bank of three single-phase, 55,000-kva. transformers**

municipal power plant, at $162,008. Work on station, with total cost estimated at $187,000, will begin soon. Rocky Mountain Engineering Co., Wilda Bldg., Denver, Colo., consulting engineer.

PUEBLO, COLO., plans power house in connection with municipal sewerage plant. Fund of $500,000 is being arranged through Federal aid. Work scheduled to begin in spring. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

STATE DEPARTMENT OF INSTITUTIONS, Olympia, Wash., is arranging funds for boiler equipment and accessories in power house at State Normal School at Ellensburg; new deep-well pumping machinery at State Penitentiary; extensions central heating system at State Normal School at Cheney; and extensions in water and sewerage systems at State Hospital at Sedro-Woolley.

LA MESA, LEMON GROVE AND SPRING VALLEY IRRIGATION DISTRICT, San Diego, Calif., plans extensions in electric pumping plant at El Monte, including new equipment. Cost about $45,000. Financing through Federal aid.

MURRAY, UTAH, is arranging Federal financing of $29,250, to which municipality will add $35,750, for extensions in municipal electric power plant, including 750-hp. engine-generator unit and auxiliary equipment. A diesel unit is under consideration. J. Clifford Hansen, commissioner in charge.

## FOREIGN STRAWS

GRANBY CONSOL. SMELTING & POWER CO., LTD., contracted Combustion Engrg. Corp., Ltd., for steam generator for Granby, B. C., plant.

SASKATCHEWAN PROVINCIAL GOV'T. has purchased municipal plant at Canora, Sask., for $25,000. A rural distributing system may be added.

J. EATON & CO., LTD., Toronto, Ont., has awarded a contract at $20,000 to W. H. Cooper, Hamilton, Ont., for construction of a boiler house and machine shop on Hughston St., Hamilton. Equipment will be purchased.

KYUSHU SODA CO., LTD., Tokyo, Japan, plans power plant at proposed ammonium-sulphate plant at Fukuoka, near Naokata. A large water-pumping station also will be built. Plant will be equipped for initial capacity of 100,000 metric tons per annum and will cost over $600,000.

ONTARIO HYDRO-ELECTRIC POWER COMMISSION, Toronto, Ont., will take bids soon for construction of hydroelectric generating plant at Ragged Rapids on Muskosh River in Georgian Bay area, including hydraulic turbines and generating units to have a capacity of about 40,000 hp. Project will include construction of transmission lines, power substations and switching stations for power supply in district noted. Cost estimated over $1,000,000. Two other power sites on same river will be developed for hydroelectric stations at a later date and will be tied-in with power plant to be constructed in 1937. Entire project will represent an ultimate investment of close to $3,500,000. Dr. T. H. Hogg, engineer for commission, is in charge of project.

NATIONAL REFINERIES CO., LTD., Dublin, Ireland, recently organized with capital of $5,000,000, plans large power plant and pumping station for new oil refinery. Total cost over $1,500,000.

ROYAL HUNGARIAN MINISTRY OF COMMERCE, Government of Hungary, Budapest, Hungary, will call tenders for electrification project in a group of rural townships, including construction of electric generating plants and installation of transmission and distributing lines, with power substation facilities. Estimated cost $500,000.

BATHURST POWER & PAPER CO., Bathurst, N. B., has appropriated $650,000 for a 110,000-lb.-per-hr. steam generating unit operating at a pressure of 650 lb., and a 6,000-kw. turbo-generator. This will be the first installation at such a pressure in Canada's paper industry.

PUERTO RICO is being visited by two TVA officials who will advise local PWA officials on building two high power dams.

MINISTRY OF COMMUNICATIONS AND PUBLIC WORKS, Government of Mexico, Mexico, D.F., has authorized a fund of 19,000,000 pesos (about $5,320,000) for initial work on a large irrigation project in 1937, to include construction of three dams on Nazas, Yaqui and San Juan Rivers. The first noted will be near El Palmito, and will provide water supply in Coahuila and Durango States; the second dam will be near Angostura in Sonora State; while the third, on the San Juan River, will be at El Azucar, and provide water service in parts of Tamaulipas and Nuevo Leon States. Project will include a series of electric-operated pumping stations, construction of power lines and other power service facilities. The complete development, to be continued in subsequent years, will cost approximately 60,000,000 pesos (about $16,800,000).

# FEAST OR FAMINE . . .

MAN, like the other meat-eating animals, seems destined always to have too much or too little to eat—feast or famine. Given the food, we gorge ourselves, then go away some place to sleep it off.

For some reason or other, man-planned things operate similarly. We always have either too many clothes or too few, too much production or not enough, too much money or not enough. Our treatment of the land now brings us either drought or flood; our treatment of our industrial plants provides us with either too much equipment or too little.

A few short months ago, every power plant had far more capacity than necessary. Most of us were afraid to, or couldn't, look ahead. Today, the situation is reversed and we have too little equipment. Prices have risen, but despite that, demand for most items of equipment is so great that orders must wait for six weeks to eighteen months for delivery. Meanwhile, we must struggle along with what we have, decrepit and wasteful as it may be.

This situation we have brought upon ourselves—or other men have brought it upon us. But mooning over it will do no good. From the time when Lot's wife, looking back, was turned into a pillar of salt, it has paid man only to profit by past experiences, not to sit and worry over them. The only hope for the future lies ahead.

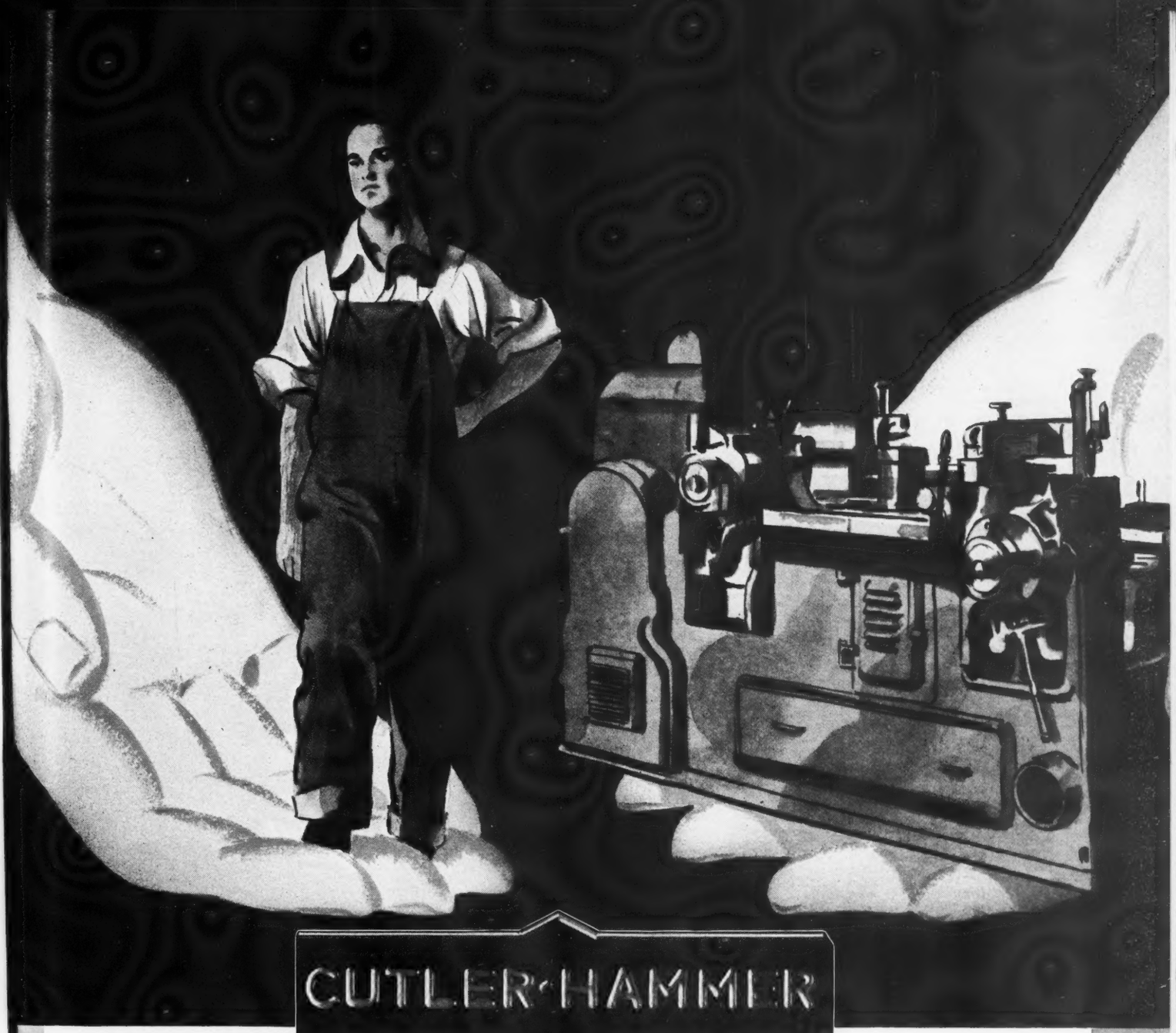
Let's assume you need equipment, major equipment, and that you've ordered it. That gives you no license to sit around and wait for delivery. When it comes, you should be ready to make use of it. There are plant rearrangements to be made, other equipment to be checked up or rebuilt, plans to be worked out. All these things you can do, and going beyond them, several others.

The purchased equipment for which you wait is probably a major unit. Well, how about auxiliaries, how about renewing piping, cleaning up insulation, getting those new gages you've needed so long? All these things are important, and lumped together, may save you almost as much as the major change you'll make as soon as you get the unit. On very small things you can get almost immediate delivery, so it serves as a stop-gap to get you in trim. And it all contributes toward lowering the cost per thousand pounds of steam.

Then, too, you can figure ahead. When the new equipment is in, will all your difficulties be settled? Not by a long shot—and you know it. A little careful figuring now, allowing for developments of the period you'll have to wait for delivery, will mean that your future power table will be set regularly and properly, no feast one day and famine the next.

George Edwards

GEORGE EDWARDS,
*Engineer*



CUTLER-HAMMER

MOTOR CONTROL

C-H

**Any buyer of electric motors or motor-driven machines who does not definitely specify the Motor Control *by name* leaves to chance not only the performance and safety of his equipment, but of the men who must use it. Judge the importance of Motor Control by what it protects and you will readily understand the overwhelming preference for Cutler-Hammer Motor Control.**

## NEW BULLETINS

**Metal Spray**—Air Reduction Sales Co., 60 E. 42nd St., New York, N. Y. 4-page leaflet No. 1204 describing "Hi-Cap Meta-Layer" for coating surfaces with molten metal.

**Blow-off Valves**—Yarnall-Waring Co., Philadelphia, Pa. 4-page bulletin No. B-419 on "Yarway" forged-steel valves for 600 to 1500 lb. pressure.

**Plug Valves**—Walworth Co., 60 E. 42nd St., New York, N. Y. Mailing piece on lubricated plug valves for corrosive service.

**Water Gages**—Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland, Ohio. 10-page bulletin on water gages with mica in place of glass.

**Flowmeters**—Cochrane Corp., Philadelphia, Pa. 12-page bulletin No. 2096 describes electric flowmeters with either pen or integral indicators.

**Steam Scrubber**—Babcock & Wilcox Co., 85 Liberty St., New York, N. Y. 8-page bulletin No. G-18 on scrubbers for freeing steam from moisture and attendant solids.

**Heating Units**—General Gas Light Co., Kalamazoo, Mich. Mailing piece on gas heaters.

**Turbo-Blowers**—Allis-Chalmers Mfg. Co., Milwaukee, Wis. 16-page bulletin No. 1909 on air-cooled, multi-stage turbo-blowers for pressures up to 35 lb.

**Rectifiers**—Allis-Chalmers Mfg. Co., Milwaukee, Wis. 12-page bulletin No. 1169-A describes construction and operation of mercury-arc power rectifiers.

**Manganese Steel**—Manganese Steel Forge Co., Richmond St. & Castor Ave., Philadelphia, Pa. 28-page booklet No. R-1, an index of applications of 11 to 14% manganese steel.

**Steam Turbines**—Allis-Chalmers Mfg. Co., Milwaukee, Wis. 20-page bulletin No. 1181 on high-backpressure, non-condensing steam turbines.

**Safety**—National Safety Council, 20 N. Wacker Drive, Chicago, Ill. Illustrated booklet describing accident prevention work reported by presidents of 23 large industries, all members of the Council.

**Depreciation**—Machinery & Allied Products Inst., 221 N. La Salle St., Chicago, Ill. 14-page booklet "Depreciation Reserve Policies" gives effect of recent legislation and presents applications of recommended policies.

**Chain Drives**—Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill. 96-page, 1936 edition of Data Book 125 on "Silverstreak" silent-chain drives of fractional hp. up to 2,000 hp. Installation pictures, tables on recommended drive selection, dimensions and prices.

**Oil-Testing Instruments**—C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y. 24-page catalog No. 699D, containing technical information and description on oil-testing instruments: thermometers, hydrometers, colorimeters, viscosimeters, and flash, fire-test and distillation apparatus.

**Rubber Goods**—Diamond Mechanical Rubber Goods Co., Akron., Ohio. 28-page buyer's guide on transmission and conveyor belts, hose, tubing and packing.

**Pulverizers**—Whiting Corp., 15600 Lathrop Ave., Harvey, Ill. 48-page illustrated bulletin No. 15 on pulverizing and pulverized-coal firing equipment.

**Turbines**—Terry Steam Turbine Co., Terry Square, Hartford, Conn. Bulletin S-114 describes multi-stage turbines. 12 pages, illustrated.

**Pipe-Line Welding**—Linde Air Products Co., 205 E. 42nd St., New York, N. Y. A complete description of Lindewelding, covering general quality and strength of welds, joint design, and field operations, and in particular time and material records on typical Lindewelded lines, construction organization and methods, specifications, technique, metallurgical considerations, multi-flame welding, and all-bell-hole method. Illustrations, 32 pages

**Arc Welders**—Hobart Bros. Co., Box DM 389, Troy, Ohio. 4-page mailing folder on "40-Volt Simplified" arc welders.

**Threading Equipment**—Oster Mfg. Co., Cleveland, Ohio. 76-page catalog on stocks and dies, hand and power pipe-threading machines. Also describes welding clamps, assembly benches, and gas-cutting machines.

**Chain Belts**—Chain Belt Co., Milwaukee, Wis. Three mailing folders describing "Rex" series of roller, "Griplock," and "Z-metal" chain.

**Diesel Engines**—Nordberg Mfg. Co., Milwaukee, Wis. Two bulletins: No. 75, 20 pages, describes 2-cycle, mechanical- and air-injection diesels of 3, 4, 5, 6, and 7 cyl.; No. 51-A, 4-cycle, mechanical-injection diesels of 3, 4, 5, 6, and 8 cyl.

# NEW PLANT CONSTRUCTION

*McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service*

**Conn., New Haven**—New Haven Pulp & Board Co., East St., plans by F. L. Smith, 21 East 40th St., New York, brick, steel, concrete power plant, incl. turbines, stokers and handling equipment. East St. $200,000-$250,000. Boiler awarded to Bigelow Co., 52 River St., New Haven.

**Fla., Fruitland Park**—Municipality plans diesel electric light and power plant. To exceed $40,000.

**Ia., Eldora**—City, G. M. Shafer, clk., constructing light plant. $100,000 allotted by REA. Young & Stanley, Muscatine, engrs.

**Ia., Hampton**—Franklin County Rural Electrical Assn., Hampton, plans constructing power plant to supply power for Franklin, Grundy, Butler and Wright Counties. $225,000. REA allotment approved. Buell & Winter, Sioux City, engrs.

**Ia., Waterloo**—Iowa Public Service Co., Waterloo, plans plant improvements incl. turbine and boiler building $150,000; concrete work, plumbing, heating, lighting, excavation 150,000; new equipment $700,000. Total est. $1,000,000.

**Kan., Sabetha**—City, c/o C. Darby, city engr., preparing preliminary report for new central heating plant, new boilers, etc., improvements to power plant, new 1,000 hp. Diesel engine, switchboard, etc. Paulette & Wilson, Farmers Union Bldg., Salina, engrs.

**Mass., South Boston**—Edison Electric Illuminating Co., 182 Tremont St., Boston, 2 story, basement, rein.-con., steel power plant, L St. Owner building by Maintenance Department. Est. $100,000. Owner is purchasing equipment and letting various contracts. Private plans.

**Mich., Charlevoix**—City Council, plans by Hamilton & Weeber, consult. engrs., 2130 Paris St. S.E., Grand Rapids, to install a new Diesel unit in municipal plant. Engineers will furnish plans and supervise construction of proposed plant addition to house new Diesel unit.

**Minnesota and Wisconsin** — Inter-County Municipality, H. Ogden, secy., Osceola, Wis. (Polk and Burnet Counties) and Federated Electrical Co-Operative, 739 Johnson St. N.E. Minneapolis (representing Pine Co., Minn.), plan constructing flood control and power project in St. Croix River at Kettle Rapids, Wis., and 78 ft. dam, 19,000 hp. power plant, etc. Federal preliminary permit is sought; congressional action contemplated whereby federal government would do work and own project. $8,000,000. W. W. Cutcliffe, 739 Johnson St., N.E., Minneapolis, Minn., engr.

**Minn., Lake Crystal**—City, G. W. Champlin, clk., voted $45,000 bonds for constructing municipal electric power plant and distribution system. $90,000. G. M. Orr & Co., 542 Baker Arcade Bldg., Minneapolis, engrs.

**Miss., Oxford**—City plans purchasing new unit for local electric light plant to be 750 h.p. engine, supplementing the 800 h.p. municipally-owned plant now in operation. City was authorized by election to issue $55,000 bonds.

**Neb., Falls City**—Municipality soon takes bids constructing improvements to diesel electric power plant. $80,000.

**Neb., Holdrege**—City making plans but not ready for further action at this time for constructing power plant improvements. $100,000. Black & Veatch, 4706 Bway., Kansas City, Mo., engrs.

**Neb., Niobrara**—Knox County Public Power & Irrigation District, W. L. Brennan, atty. making plans constructing dam, power plant, and irrigation project on Niobrara River. $1,500,000. Plans will be ready in about 90 days to be filed with state engineer. Mead, Ward & Hunt, Madison, Wis., engrs.

**N. Y., New York**—New York Steam Corp., 130 East 15th St., plans by W. H. Paine, archt. and engr., c/o owner, steam power generating plant. 37 Sutton Pl. $40,000 with equipment.

**N. D., Watford City**—Village plans power house and equipment. Special committee making inquiries regarding cost, etc. Mae Scollard, village clk.

**O., Cleveland**—City, F. D. Wallene, dir. P. Utilities, plans municipal light plant addition, 15,000 kw. generator new boilers, equipment and distribution lines, East 53rd St. and Lake Erie, $2,000,000. P.W.A. project. Applied for federal funds. L. O. Quayle, City Hall, ch. engr.

**O., Hamilton**—Municipality soon takes bids electric light and power plant addition, $50,000. Froelich & Emery, 2nd Natl. Bank Bldg., Toledo, engrs.

**O., Painesville**—Industrial Rayon Corp., West 98th and Walford Sts., Cleveland, plans 12,000,000 lb. capacity rayon plant, incl. power plant. Est. $10,000,000.

**O., Port Clinton**—City plans municipal light plant and system. Est. about $40,000. Special election on issue in February.

**O., Sandusky**—City plans municipal light plant. Est. about $40,000. Application made for P.W.A. funds.

**O., Springfield**—Ohio Edison Co., H. E. Miller, mgr., making plans addition to present Mad River plant, installing new turbine condenser, new booster and stoker and auxiliaries. $2,000,000. Commonwealth & Southern Corp., Jackson, Mich., engrs. **Maturity about April.**

**O., Uhrichsville**—Municipality plans electric light and power plant. To exceed $40,000.

**Okla., Anadarko**—City, J. F. Callahan, mayor, plans municipal light and power plant additions, 1 diesel engine, 1,000 hp.; one 700 kw. generator, monolithic concrete building and appurtenances. P.W.A. project. $99,778. R. O. Bradley & Co., Chickasha, consult. engr.

**Pa., Bradford**—Bradford Oil Refining Co., J. P. Andrews, genl. mgr., plans constructing modern cracking unit, reforming unit, solvent dewaxing plant and extensions to boiler and filter plant at crude oil refinery. $350,000. Project to be financed by $350,000 bond issue approved by S.E.C. **Maturity soon.** F. J. Steckmeyer, c/o owners, ch. engr.

**Pa., Braddock**—Carnegie Illinois Steel Co., B. Fairless, Carnegie Bldg., Pittsburgh, plans 1,000,000 ton slabbing mill for Edgar Thomson Wks., and installation large and numerous new electric power producing facilities with transmission lines from Braddock to Clairton, $15,000,000. J. E. Graf, Carnegie Bldg., Pittsburgh, engr.

**Pa., Cresson**—Penn Central Light & Power Co., B. F. Cleaves, vice pres., chn. oper., Penn Central Bldg., Altoona, 17 mi. 110,000 volt transmission lines extending from new substation to Mundy's Corners, and also electric substation. Owner builds with own forces. Est. $360,000. Private plans.

**S. D., Beresford**—Municipal Light Plant plans furnishing, installing 450 to 500 h.p. engine unit, alterations and additions to plant building and additional switchboard equipment. $55,000. A special election planned for February to pass on $30,000 bond issue. J. M. Engberg, Beresford, engr.

**S. D., Sioux Falls**—Northern States Power Co., 15 South 5th St., Minneapolis, Minn., plans electric power substation. To exceed $40,000 with equipment. Private plans.

**S. D., Watertown**—State Bd. Charities & Corrections, Pierre, plans constructing administration building, power house, two dormitories, water supply, sewage disposal plant, power lines, etc., Northeastern Hospital for Insane, contingent upon legislative appropriation and P.W.A. grant, Chamber of Commerce, J. A. Hoffman, secy. interested. $650,000.

**Tex., Brenham**—City, c/o Reese Lockett, mayor, plans ordered stopped for municipal light and power plant, as Texas Power & Light Co., obtained temporary restraining injunction to prevent Harold Ickes from releasing P.W.A. funds for project. The next move will be an effort to make the injunction permanent. $300,000. Garrett Eng. Co., Box 1726, Houston, and Brenham, engrs.

**Tex., Harlingen**—Fidelity Products Co., Brownsville, subsidiary of Wesson-Oil-Snowdrift Co., Canal Bank Bldg., New Orleans, La., completing plans for cotton seed oil mill, power unit probably diesel operated. $150,000. Private plans. Interested dealers and contractors should communicate with owners regarding contracts.

**Tex., Sulphur Springs**—City taking bids construction brick, concrete power plant. $100,000. Municipal Eng. & Finance Co., Sulphur Springs, and Burt Bldg., Dallas, engrs.

**Utah, Murray**—City, c/o City Clerk, filed application with P.W.A. for $29,250 grant for construction $65,000 diesel engine unit addition to its present municipal power and light plant. J. C. Hansen, city comr., in charge of proposed improvement.

**Va., Danville**—Bids Feb. 23, for Cont. 14, by B. A. Pollok, purch. agt., room 309, City Hall, hydraulic equipment and accessories consisting three 4500 h.p. 450 RPM impulse wheels under 660 ft. head, all inlet pping and valves and control apparatus for Pinnacles Project. Chas. T. Main, Inc., engr.

**Wis., Tomahawk**—Wisconsin Public Service Co., 1029 North Marshall St., Milwaukee, plans constructing dam and power plant. $480,000. Private plans.

**Ontario**—Ontario Hydro-Electric Power Comn., 190 University Ave., Toronto, bids early in 1937 constructing storage dam on Frederickhouse River, which will provide for additional load of approximately 40,000 hp. making a total of 315,000 hp. for Abitibi plant in Abitibi area. $500,000.

**Ont., Arnprior** — Ontario Hydro-Electric Power Comn., 130 University Ave., Toronto, has plans under consideration for 20,000 to 30,000 hp. hydro power development at High Falls on Madawaska River. Est about $1,000,000.

**Ont., Swansea**—Municipality making plans hydro-electric plant extension. $65,000. A. Smith, Town Hall, engr.